General Report
Survey of India
1905-06 & 1908-09

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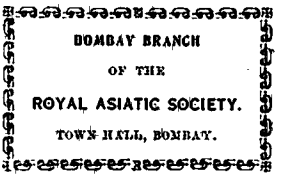

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GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1905-06.

134606.
or
& 1908-09

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E.,

SURVEYOR GENERAL OF INDIA.

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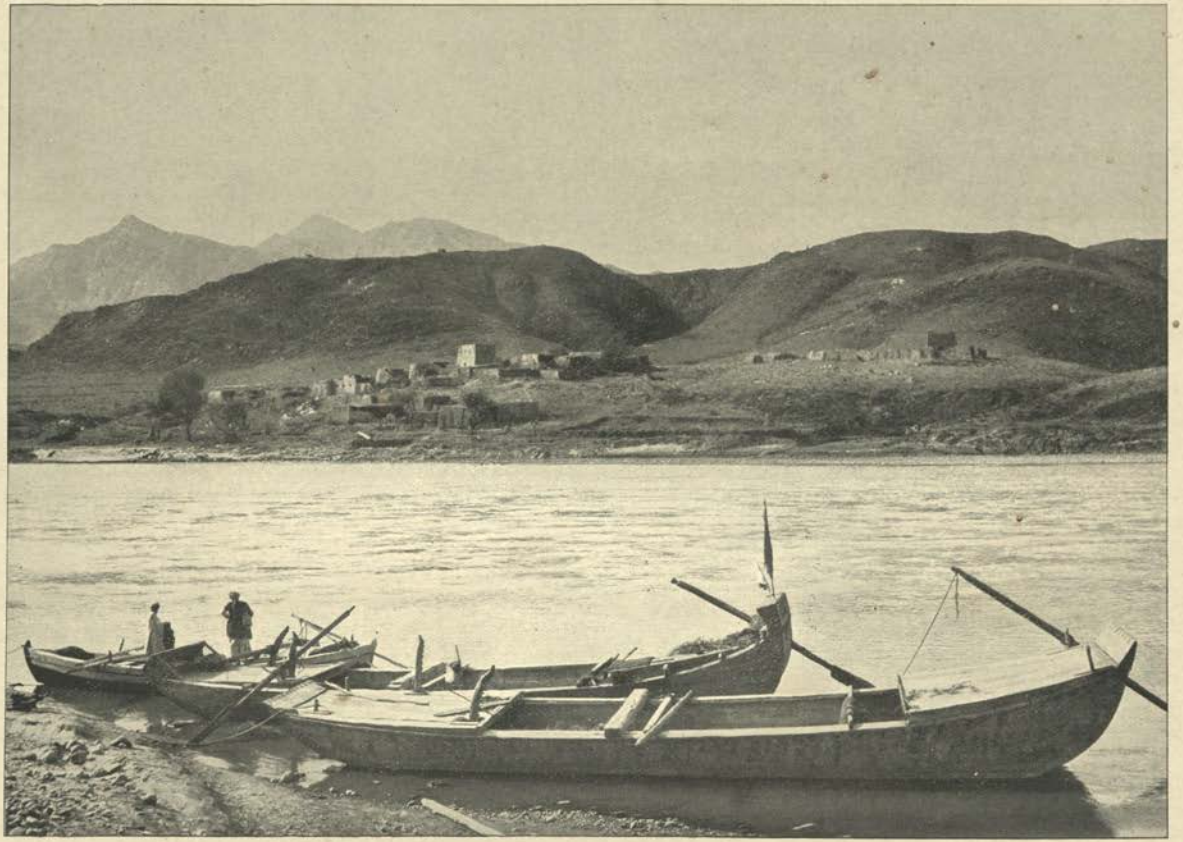

Half-tone Block.

Survey of India Offices, Calcutta, 1907.

VIEW ON THE KABUL RIVER.

From a negative by Captain E. T. Rich, R.E.

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CEYLON

BAY OF BENGAL
INDEX CHART
OF THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA

Reg. No. 456-S. 07.

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1905-1906.

PART I.

SUMMARY.

ADMINISTRATION.

1. This report deals with the operations of the Department for the survey year ending the 30th September 1906.

Colonel F.B. Longe, R.E., administered the Department throughout the year, while Lieutenant-Colonel G. B. Hodgson, I.A., held the position of Deputy Surveyor General, Lieutenant-Colonel S. G. Burrard, F.R.S., R.E., that of Superintendent, Trigonometrical Surveys, Major P. J. Gordon, I.A., that of Superintendent, Forest Surveys, and Major R. T. Crichton, I.A., that of Superintendent, Provincial Surveys, Bengal, for the same period.

Pending final reorganisation a new appointment called Superintendent, Frontier Surveys, was temporarily created. To fill this Major C. H. D. Ryder, D.S.O., R.E., was recalled from furlough and assumed charge on the 5th August 1906.

2. In the present report the new system of numbering the standard sheets on the scales of 1 mile and 4 miles to the inch has been generally followed and index maps of the form referred to in paras. 14 and 15 of last year's report are published in illustration of the text. Specimens of a degree sheet and a 1 inch sheet are also published.

3. Owing to the impossibility of obtaining the services of an officer with the requisite technical knowledge to reorganise the Photo-Lithographic offices this important duty could not be carried out. Mr. T. LeMesurier, the Superintendent of the Poona Photo-Lithographic office, was lent to the Government of India for the purpose, but on arrival in Calcutta he was in failing health and was forced to go to the General Hospital within a few days and gradually sinking he died there on the 6th February.

The Secretary of State for India has, however, now secured the services of Major W. C. Hedley, R.E., of the Ordnance Survey, for a period of two years, and he is expected to arrive in Calcutta in October 1906, and the reorganisation of these offices will therefore no longer be delayed.

4. The details of the reorganisation of the Department were under discussion throughout the year. Considerable progress has been made, and it is hoped that final orders will be issued during the coming survey year. Meanwhile surveys and mapping have been started on the lines recommended by the committee and a large number of maps should be published during next year.

Owing to the great difficulty in selecting symbols suitable for the whole of India and its adjacent countries, and to the changes in the type used for the lettering, necessitated by the new system of drawing all maps for reduction instead of reproduction, it cannot be expected that every map on any one scale will be exactly similar with regard to such details, but every endeavour is being made to

have them as nearly so as possible and such as are not in accordance with the latest orders will be published as preliminary editions and replaced as opportunity offers.

It must be remembered that each party prepares its own maps during the recess season by the agency of its field surveyors and that the parties are working in all parts of the country and under almost inconceivably different conditions, and while changes so material as the present are being introduced, it is not to be expected that all will interpret details in exactly the same way, the concentration of parties into groups under Superintendents will, however, greatly facilitate matters in future. The work on the whole has been very satisfactory and though the changes have thrown a great deal of troublesome and tedious work on the Head-quarters Drawing and Photo-Lithographic offices good progress has been made.

During the coming year the Department will suffer considerably owing to the absence on furlough of many of its senior officers, but they can be better spared now while the details of reorganisation are being worked out than they could be later, and it will gain on their return by having their services available for a long period during which they will carry into effect the new arrangements and set them on a sound and permanent footing.

5. The tabular statements in Part II have been arranged in a somewhat different form to those of previous years and it is hoped that references will thereby be simplified.

Inspection Tours of Administrative Officers.

6. Colonel F. B. Longe, R.E., inspected the office of No. 1 party and the North-West Frontier drawing office in Mussooree early in October; he then, on October 12th, visited Dehra Dún, where in addition to inspecting the Forest Survey office and that of No. 20 party he discussed the future programme of the forest survey parties Nos. 9, 17, 19 and 20 and returned to Calcutta on October 20th. On the 5th February he again visited Dehra Dún and inspected the drawing offices of the North-West Frontier and No. 15 party and the reproducing section of the Great Trigonometrical Survey office; in consultation with the Superintendent, Trigonometrical Surveys, and the officer in charge of the Computing Office he also decided on the projections to be employed and other important details in connection with the future maps of the Department, returning to Calcutta on February 20th. On April 5th he left Calcutta and after visiting Bhim Tal and Naini Tal in order to investigate the suitability of the former place as a recess quarter for survey parties he arrived in Simla on the 15th April. On July 21st he left Simla on a tour of inspection, visiting in turn Calcutta (July 24th to 31st), Dehra Dún and Mussooree (from 2nd to the 14th) and returning to Simla on 15th August; in Calcutta he inspected the Drawing, Photo-Lithographic and Mathematical Instrument offices, at Dehra Dún, the Great Trigonometrical, Photo-Lithographic and Forest Survey offices, and at Mussooree the offices of Nos. 1, 12, 14 and 15 parties and the North-West Frontier drawing office. On his return to Simla he inspected the office of No. 18 party.

7. Lieutenant-Colonel G. B. Hodgson, I.A., Deputy Surveyor General, inspected the United Provinces drawing office at Naini Tal in October 1905 and again in September 1906; he inspected Nos. 1 and 2 parties in the Central Provinces during the field season and again during recess at Mussooree and Poona. In May 1906 he proceeded to Burma and inspected No. 7 party at Maymyo and No. 11 party at Taunggyi in the Southern Shan States, and in July he inspected Nos. 3 and 10 parties and the Burma drawing office at Bangalore. He visited the Bengal drawing office at Calcutta on many occasions.

8. Lieutenant-Colonel S. G. Burrard, F.R.S., R.E., Superintendent, Trigonometrical Surveys, inspected No. 25 party (Tidal and Levelling) in November at Dehra Dún and No. 23 party (Pendulums) in the field in March. In September he inspected Nos. 22, 23, 24, 25 and 26 parties at their recess quarters in Mussooree. He also inspected the Survey Training School from time to time during the year.

9. Major P. J. Gordon, I.A., Superintendent, Forest Surveys, inspected in the field the detachments of No. 9 party working in Assam and Burma. He

also inspected No. 20 party in the field in Burma and in recess at Dehra Dún, and No. 17 party at Poona and No. 19 party at Bangalore. He visited the Andamans in connection with the boundary surveys in the Northern Island which were being carried on under the officer in charge of forest working plans.

10. Major Ryder, D.S.O., R.E., Superintendent, Frontier Surveys, accompanied the Surveyor General to Mussooree on August 5th and thence to Simla on August 14th where the transfer to his charge of the parties in his circle was completed. While in Simla he inspected No. 18 party on 22nd August and returned to Mussooree on August 30th. While in Mussooree he constantly inspected the parties recessing there, namely, Nos. 12, 14 and 15 and the North-West Frontier drawing office.

DISTRIBUTION OF FIELD PARTIES.

11. Field operations were carried out by 22 parties and 4 detachments; of these 9 were employed on topographical surveys, 4 on forest surveys, 3 parties and 1 detachment on cadastral surveys, 1 party on both cadastral and topographical surveys, 3 detachments on cantonment surveys, 1 party on triangulation and 4 on scientific operations. In the following statement the whole of the operations are grouped according to the nature of the work on which the parties were employed:—

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	TOPOGRAPHICAL.			Inches. Miles.	
1	Central Provinces	17	Captain A. H. B. Hume, R.E.	2 = 1	D. S. G.
2	Berar	18	Captain H. Wood, R.E. Mr. C. F. Erskine	2 = 1	Ditto.
3	Lower Burma	19	Mr. E. F. Litchfield	1 = 1	Ditto.
10	Upper „	20	Captain A. A. McHarg, R.E.	1 = 1	Ditto.
11	Shan States	21	Lieutenant R. H. Phillimore, R.E.	1 = 1	Ditto.
12	North-West Frontier	22	Captain E. T. Rich, R.E. Mr. R. F. Warwick	2 = 1	S. G. and S. Frontier Surveys.
14	„ „	23	Captain H. L. Crosthwait, R.E. Lieutenant E. C. Baker, R.E.	2 = 1	Ditto.
15	„ „	24	Major C. L. Robertson, C.M.G., R.E.	2 = 1	Ditto.
18	Punjab „	25	Captain M. O'C. Tandy, R.E.	2 = 1	Ditto.
6	Eastern Bengal	36	Mr. A. W. Smart	4 = 1 2 = 1	S. P. S., Bengal.
	FORESTS.				
9	Eastern Bengal and Assam. United Provinces Central „ Punjab Burma North-West Frontier Province.	28	Major P. J. Gordon, I.A.	4 = 1 2 = 1	S. Forest Surveys.
17	Bombay Presidency	30	Mr. B. G. Gilbert-Cooper	8 = 1 4 = 1	Ditto.
19	Madras „	31	Mr. G. T. Hall	4 = 1 2 = 1	Ditto.
20	Burma	32	Captain A. Mears, I.A.	4 = 1 2 = 1	Ditto.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	CADASTRAL AND TRAVERSE.			Inches. Miles.	
4	Bihar	34	Captain F. C. Hirst, I.A.	16 = 1	S. P. S., Bengal.
5	Chota Nagpur	35	Captain F. C. Hirst, I.A. Captain L. C. Thuillier, I.A. Mr. T. W. Babonau	16 = 1	Ditto.
6	Eastern Bengal	36	Mr. A. W. Smart	16 = 1	Ditto.
Det.	Calcutta	38	Mr. R. B. Smart	105·6 = 1 32 = 1	Ditto.
7	Burma	39	Major C. W. H. Symonds, I.A. Mr. J. S. Swiney Mr. O. D. Smart	16 = 1	D. S. G.
Section No.	CANTONMENT SURVEYS.				
1	Northern Command	40	Mr. J. McHatton	16 = 1 64 = 1	D. S. G.
2	Western "	41	M. E. G. Little Mr. L. J. Pocock	16 = 1 64 = 2	Ditto.
3	Secunderabad Division	41	Mr. L. J. Pocock Mr. E. G. Little	12 = 1 48 = 1	Ditto.
	TRIANGULATION.				
24	India	42	Captain H. H Turner, R.E. Mr J Eccles, M.A. Lieutenant C. M. Browne, D.S.O., R.E. Major G. P. Lenox-Conyngham, R.E.	...	S. T. S.
	SCIENTIFIC.				
22	Azimuths	43	Lieutenant-Colonel S. G. Burrard, F.R.S., R.E.	...	S. T. S.
23	Pendulums	44	Major G. P. Lenox-Conyngham, R.E.	...	Ditto.
25	Tidal and Levelling	4	Mr. C. F. Erskine Mr. J. P. Barker	...	Ditto.
26	Magnetic	49	Captain R. H. Thomas, R.E.	...	Ditto.

RESULTS.

12. The total outturn of detail topographical and forest surveys on all scales is 23,312 square miles against 26,340 square miles of similar surveys during the previous year, no surveys on a smaller scale than 1 inch = 1 mile were carried out during the year; the total area triangulated or traversed for topographical or forest surveys is 27,134 against 19,265 square miles for the previous year. The decreased topographical outturn is mainly due to the transfer of Nos. 12 and 14 parties from Sind and the United Provinces to the North-West Frontier. These two parties which surveyed during 1904-05 2,787 and 2,426 square miles respectively were, owing to local circumstances and changes in personnel, only able to survey 753 and 737 square miles, respectively, during the year under report, which represents a decrease of 3,723 square miles. The total area of cadastral and special surveys was 2,982 square miles, and the area traversed was 6,464 square miles, as compared with 7,305 square miles of survey and 6,398 square miles of traversing for the previous year. The decrease in cadastral outturn is due to the transfer of the cadastral work in Bengal to the Settlement Department.

TOPOGRAPHICAL SURVEYS.

13. Towards the end of the year a new party was organised for topographical surveys near Quetta and at the commencement of the field season No. 14 party was moved from the United Provinces and No. 12 party from Sind to the North-West Frontier Province. With these exceptions surveys were generally in continuation of last year's work. No. 8 party, which had previously worked in the United Provinces, was broken up, the surveyors being drafted into other parties. No. 2 party continued to be largely a training party for young Provincial officers.

14. *North-West Frontier Province.*—Numbers 12, 14 and 15 parties continued their surveys on the scale of 2 inches = 1 mile. The work of all these parties was at times delayed from climatic or political causes, and in order to complete its programme No. 15 party had to remain out in the field until July, which proved a severe strain on all its members. Progress was also delayed through want of triangulation in advance of the detail survey.

The total areas of survey and triangulation were :—

	Square miles.
Survey 2 inch	2,948
Reconnaissance 2 inch	143
„ 1 inch	140
Triangulation	5,060

15. *Punjab.*—Number 18 party completed an area of 2,343 square miles on the 2-inch scale of supplementary survey in Multán, Muzaffargarh, Dera Gházi Khán districts and in Bahâwalpur State ; revision survey on the 2-inch scale of 330 square miles in the Muzaffargarh "Thal," and a re-survey on the 1-inch scale of 374 square miles in Bahâwalpur State. District traverses for supplementary survey were carried out in Jhang, Lyallpur, Montgomery, and Shahpur districts and in Bahâwalpur State and some special traverses in Kohat district.

The field work of all the riverain traverses of the Punjab was completed.

16. *Central Provinces.*—Number 1 party completed the re-survey of 1,320 square miles and the supplementary survey of 766 square miles on the 2-inch scale.

17. *Burma.*—Numbers 3, 10 and 11 parties continued surveys on the 1-inch scale and completed 9,248 square miles of which 2,096 square miles was supplementary survey, 140 square miles was supplementary survey of forests and the remainder new survey.

18. *Bengal.*—In the Sunderbans of the 24-Parganas, No. 6 party surveyed 456 square miles on the 4-inch scale and 594 square miles on the 2-inch scale. In conjunction with the cadastral surveys of Purnea and the Sonthal Parganas areas of 23 and 22 square miles were topographically surveyed on the 4-inch scale by No. 4 party.

19. *Berar.*—Number 2 party surveyed on the 2-inch scale 1,124 square miles.

20. *Eastern Bengal and Assam.*—Number 9 party, in addition to its forest survey operations, topographically surveyed on the 2-inch scale an area of 571 square miles in the Darrang district.

21. The total outturn of topographical surveys on the 4-inch, 2-inch and 1-inch scales is as follows :—

	Square miles.
North-West Frontier Province	3,231
Punjab	3,047
Central Provinces	2,086
Burma	9,248
Bengal	1,073
Berar	1,124
Eastern Bengal and Assam	571
TOTAL	20,380

FOREST SURVEYS.

22. The forest survey operations during the year were generally in continuation of those of the previous season.

In addition to the large scale forest surveys No. 9 party carried out 2-inch topographical surveys in Assam.

23. *Madras.*—In Madras No. 19 party carried out the 4-inch detail survey of the forests in Godavari, Ganjam, Chingleput, South Canara and North Malabar districts. The outturn of topography was 832 square miles at a cost of R104 per square mile.

The outturn compares favourably with that of last season when an area of 750 square miles was surveyed on the 4-inch scale at a cost of R123 per square mile.

The unhealthiness of the forest tracts, the scattered nature of the blocks, and the difficulties and delays experienced in obtaining local labour combined to prevent a greater increase in the outturn or reduction in cost-rates.

An area of 2,150 square miles was triangulated in Malabar preparatory to the 2-inch topographical survey in that district which will be commenced next season.

The traversing of the Mysore—South Canara boundary as demarcated by officers of the Madras government and Mysore State was continued.

It is proposed to discontinue 4-inch surveys of the forests in the Madras presidency with the exception of those in the Ganjam district which it is hoped will be completed next season.

Number 19 party will in future be employed on regular topographical surveys in the Madras presidency.

24. *Bombay.*—Number 17 party completed the survey of the forests in the Thana district on the 8-inch, and of those in the Satara district on the 4-inch scale. The 4-inch survey of the forests in Khandesh was continued and triangulation was completed in that district.

An area of 631 square miles was surveyed on the 4-inch scale, and 126 on the 8-inch at a cost of R87 and R173 per square mile, respectively. Owing to the difficult nature of the country and to the forest blocks being widely scattered the outturn was less and the cost-rates greater than in previous seasons. A sickly season also affected the outturn. As the cost of the publication of maps was taken into account for the first time for the purpose of calculating the cost-rates, it is difficult to arrive at a satisfactory comparison between the rates for the year and those of preceding years.

The government of Bombay having decided that the value of the remainder of the Khándesh forests does not justify the increased cost of a large scale survey, it has been decided, with certain unimportant exceptions, to employ No. 17 party in future on regular topographical surveys on the 2-inch scale.

25. *Burma.*—An area of 682 square miles was surveyed by No. 20 party in the Pakôkku and Thaungyin districts, and advance triangulation and traversing over an area of 1,622 square miles was also carried out for general topographical purposes in the former district.

The cost-rate of traversing was the lowest yet recorded, being only R43 per linear mile: the cost of triangulation was somewhat greater than for last year, chiefly owing to work having had to be suspended for two months on account of hazy weather. The general cost-rate of detail survey was R148 per square mile, or R7 more per square mile than for last season; this was due to the expensive nature of the work in Thaungyin where the rate was R154 per square mile. The cost-rate in the Chindwin where the bulk of the work lay was R142 per square mile or practically the same as for last season.

The policy of generally discontinuing large scale forest surveys having been adopted in Burma, No. 20 party will be employed next season chiefly on 2-inch topographical surveys in Pakôkku, while triangulation and traversing will be carried out in Assam to which province it is proposed to transfer the party.

26. Number 9 party, as formerly, was much scattered, being chiefly employed on 4-inch forest surveys in Burma, the North-West Frontier Province, the Punjab, the United Provinces and Eastern Bengal and Assam. In addition to forest surveys a detachment of the party also surveyed an area of 571 square miles on the 2-inch scale in the Darrang district, Eastern Bengal and Assam.

Full details regarding its outturn and cost-rates are given in Part II of this report as well as in the special annual report of the forest survey branch.

As no forest survey work will remain for No. 9 party after this year, it is proposed to transfer some of its members to other parties and to form a new party bearing the same number for work on the North-West Frontier.

27. The total outturn of the forest survey branch during the year amounted to 3,707 square miles of topography including 571 square miles on the 2-inch scale.

Sixty-nine thousand and twenty-three square miles of gazetted forests throughout India have now been surveyed on various scales for forest purposes.

CADASTRAL AND TRAVERSE SURVEYS.

28. One cadastral and one traverse party were employed in Bengal, and the Calcutta suburbs survey was continued under the control of the Superintendent, Bengal Surveys. One traverse party was employed in Eastern Bengal and one cadastral party in Burma. These operations were all in continuation of the previous season's work. In the United Provinces all operations connected with cadastral surveys were transferred to the control of the Land Records Department assisted by two officers of the Provincial service, five officers were thus released for work elsewhere. In Bengal the Settlement Department took over the control of the cadastral survey in Chota Nagpur and one officer of the Provincial service was attached thereto as a professional adviser. In Bihar the operations were carried out by the Survey of India as hitherto and this arrangement will continue for one season more, after which the whole of the cadastral surveys in Bengal will be done by the Settlement Department.

In Eastern Bengal, cadastral survey was suspended for the season and all such work will in future be done by the Settlement Department. In Assam the whole of the survey operations were transferred to the control of the Land Records Department, an officer of the Provincial service being deputed as a professional adviser.

29. The outturn of work done by the Survey of India in Bengal was the traversing of 4,433 square miles, the cadastral survey of 1,769 square miles, 45 square miles of topographical survey, and the record writing of 1,593 square miles. In the Calcutta suburbs only 267 acres were surveyed and 1,444 were traversed. The work of the season consisted mainly of the demarcation of holdings in areas previously surveyed and the completion of the maps of former seasons as they were received back after attestation. In Eastern Bengal 1,744 square miles were traversed for cadastral survey.

In Burma the outturn was 548 square miles of traversing and 1,170 square miles of cadastral survey, all in the Pakôkku district, the survey of which will be completed next season. In the Central Provinces, the boundaries of 43 detached villages, scattered over 4 districts were traversed for the Settlement Department by one of the topographical parties employed there. The chaining amounted to 213 linear miles.

30. Special large scale surveys based on traverses were carried out in 33 military cantonments and bazaars by 3 cantonment sections.

31. The total outturn of traversing and cadastral survey is as follows :—

Province.	Traversing square miles.	Cadastral survey square miles.
Bengal	4,433*	1,769
Eastern Bengal and Assam	1,744	...
Burma	548	1,170
Cantonment Surveys	69	43
TOTAL	6,794*	2,982

TRIGONOMETRICAL SURVEYS.

32. The programme of the triangulation party (No. 24) was to prolong the isolated Kalát Series eastwards and to connect it with the Great Indus Series. The work was successfully completed, and this important series of triangulation now stretches from the Indus through Northern Baluchistan, as far west as longitude 64° 30′. It will eventually reach Koh-i-Malik Siah the trijunction point of Baluchistán, Afghánistán and Persia.

An extension of the Kalát Series across Persia to the Euphrates would be a very valuable contribution to geodetic science, for the parallel of 30°, along which the series is trending, traverses a greater continuous length of land surface than any other parallel of latitude on the Earth.

* Includes 330 square miles of traversing for topographical surveys.

The future of geodesy lies in long arc measurements: the continent of America is to be measured from Baffin's Bay to Cape Horn: Sir David Gill's arc will extend from the Cape of Good Hope to Lapland: an Indo-Russian arc may possibly connect Cape Comorin and Nova Zembla and the present Kalât Series will form one section of the great arc of parallel which will embrace Asia and Africa and extend from Shanghai to Morocco.

SPECIAL OPERATIONS.

33. During this year systematic vertical observations of the Himalayan peaks of Kedarnath, Srikanta, Jaunli, Bandar Punch, and Nanda Devi from stations near Dehra Dún were commenced. During the recess season Mr. H. G. Shaw observed the peaks whenever they were visible; if this series of observations can be continued over five or six years, the varying effects of refraction and snow-fall will be deducible.

34. The pendulum operations were carried across the plains of the Punjab from Simla to Quetta. The results have proved that a zone of excessive density crosses the Punjab plains from north to south, underlying Montgomery, Ferozepore and Mian Mir. The existence of this zone had been inferred before from the peculiar direction in which gravity had been found to act at Amritsar and Multán: at both these places the plumb-line had been observed to be deflected away from visible mountains towards flat plains, and now the pendulum has shown that an excess of mass is lying hidden under the plains.

35. Tidal operations were continued by No. 25 party, observations being recorded at nine stations. The observatory at Okha in Cutch was closed during the year. The re-opening of the observatory at Moulmein was considered.

36. A second levelling detachment was formed at the commencement of the field season of 1905-06 and the two detachments have worked throughout the year. Twenty-one Standard Bench Marks were erected in large towns and levelled to. The programme of levels along the Indus in Sind was completed. A line of levels was commenced that will connect Lahore with Ráwalpindi and complete the Punjab levelling circuit.

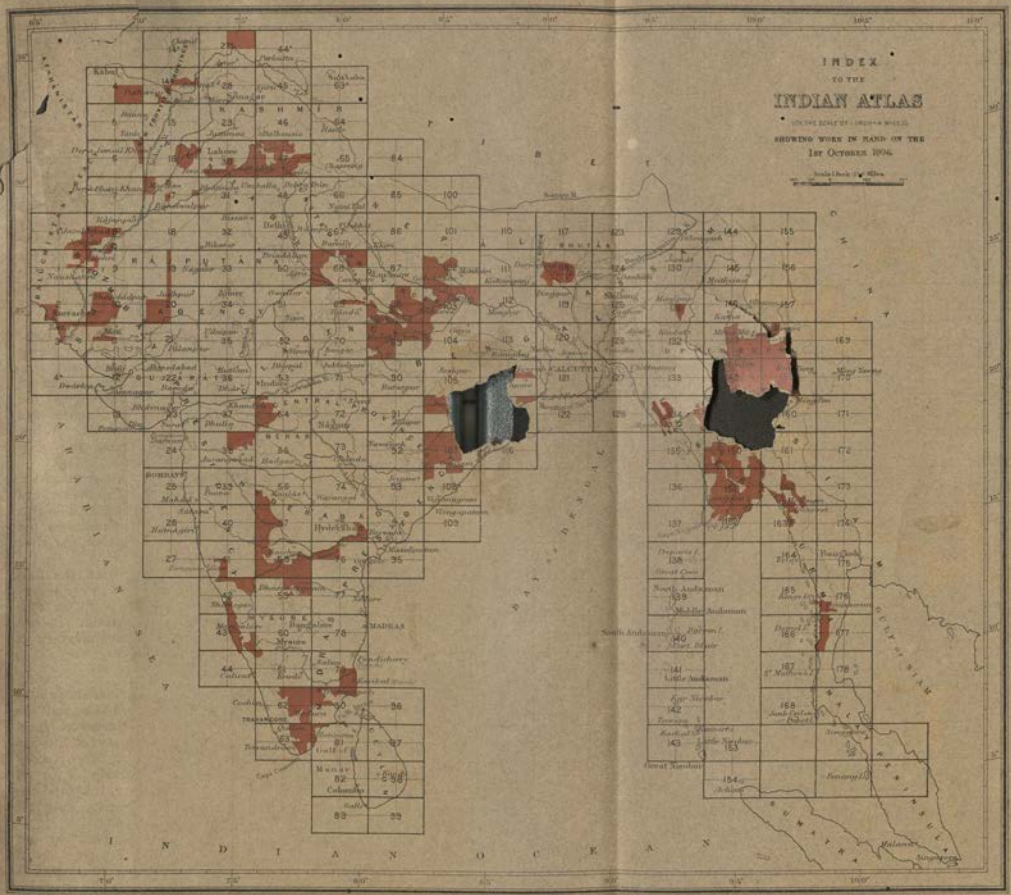
The bench marks east of the Brahmaputra had never been connected either with a tidal observatory or with any bench mark on the west of the river: thus though their differences of height had been well determined their actual heights were not known. During 1905-06 levelling operations were carried across the Brahmaputra at Dhubri and the two systems of levels on either side of the river were connected.

37. Four detachments of No. 26 party continued and extended the field work of the magnetic survey over different portions of the country. Very abnormal values of terrestrial magnetism have been found to exist in eight or nine different places in India, and more detailed surveys will be required. In one locality in the Rajputana desert the magnetic declination varies three degrees in 40 miles.

HEAD-QUARTERS OFFICES, CALCUTTA.

38. The general superintendence of these offices continued under Colonel F. B. Longe, R.E., Surveyor General. The Surveyor General's and the Mathematical Instrument offices were in charge of Brevet Lieutenant-Colonel T. F. B. Renny-Tailyour, R.E., throughout the year, except in June when Captain G. A. Beazeley, R.E., held charge; the Drawing, Engraving and Map Record and Issue offices were under Lieutenant-Colonel W. J. Bythell, R.E., till January and subsequently under Lieutenant-Colonel J. M. Fleming, I.A., and the Photo-Lithographic office under Lieutenant-Colonel J. M. Fleming, I.A., till January and afterwards under Lieutenant-Colonel W. J. Bythell, R.E.

39. *Drawing Office.*—The work done in this office during the year has been of a more or less unsatisfactory nature, owing to the changes necessitated by the recommendations of the late Survey Committee. Owing to alterations in dimensions and style and to change of symbols used on the departmental maps, most of the sheets sent in by the parties during the year have been submitted in a more or less irregular style, necessitating their revision in this office at the expense of its legitimate work. The details connected with the new sheets, as well as the symbols to be used upon them, could not be arrived at without the preparation of many preliminary specimens involving



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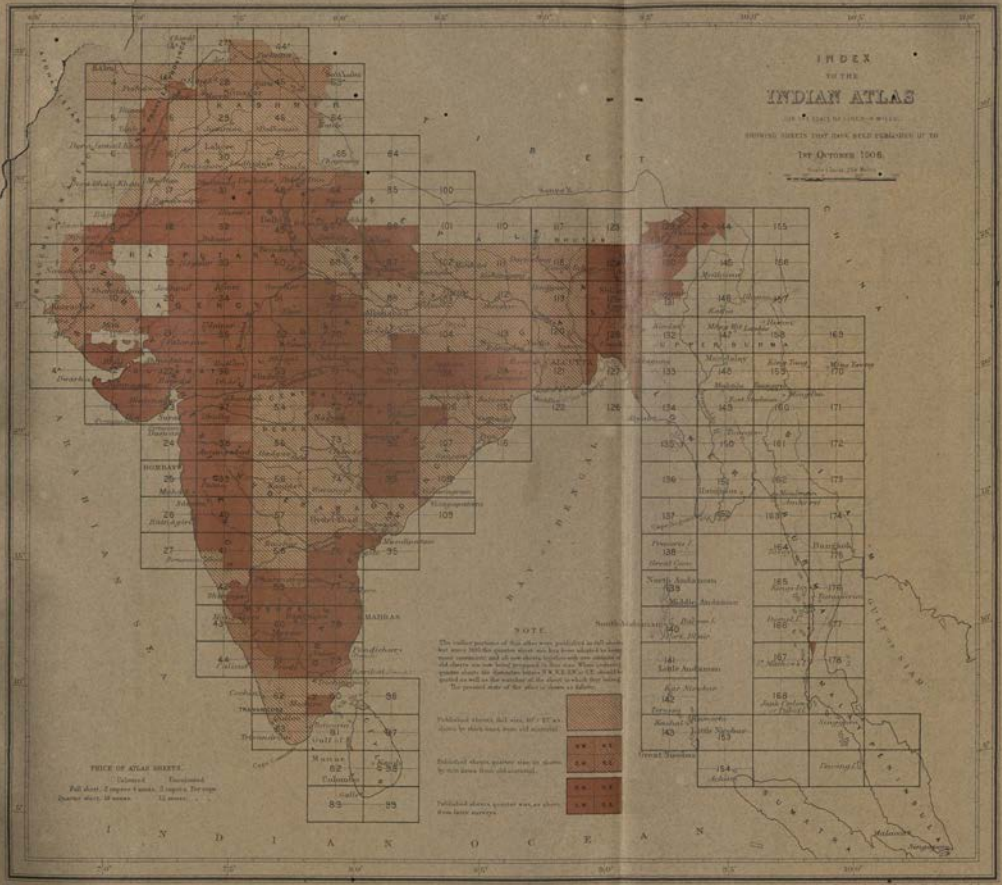

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July 1906.

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Litho. G. I. O. Calcutta.

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much labour, but it is hoped things are now approaching finality. A large number of sheets prepared for an important extra-departmental order had also to be entirely remodelled owing to difficulties in connection with printing, and but little new mapping has been undertaken.

40. Work on the old form of the Indian Atlas being suspended except as regards plates actually in hand, additional compilation was done for only 23 sheets. Additions to the details on 18 more were carried out in order to make them available for publication.

41. The publication of the general maps of India is still in abeyance. It was reported last year that owing to extensive internal administrative changes the issue of the new 32 and 64-mile maps of India could not be effected, and this year owing to constant references regarding the external boundaries of India, and the symbols by which they should be shown being still unsettled, the publication of these important maps is not yet effected. Thus owing to unavoidable circumstances the new 1-inch = 32 mile map which at its inception it was hoped would have been available in 3 years at most is, at the end of six years, still unpublished, and the department is at present in the curious position of not having any general map of India available for issue, the stock of old maps having been exhausted. The old plates and stones have been altered to meet new conditions, but as these have not been finally approved they cannot be printed from. A certain amount of work has been done on the plates and stones of the 32 and 64-mile maps, but no large amount of revision could be undertaken as the receipt of orders for publication was continually expected. Work on the 80, 96, 128, and 192-mile maps of India has proceeded steadily and the last three could be sent to press almost immediately after the receipt of orders regarding boundaries. The projection of the plates for the new engraved 32-mile map of India in 12 sheets on the recently revised secant conical projection has been commenced and several of the plates are ready for the detail engravers. The skeleton 64-mile District Map of India has been brought up to date and published during the year, but is of little use for general purposes. It has been decided to push on a photo-zincographic edition of the $\frac{1}{M}$ series of maps, and sheets 85 and 94 have been prepared on the old projection, thus completing the Burma sheets of the series. Similarly in order to provide a map of Eastern Bengal and Assam on this scale, sheet 79 has been taken in hand and is practically completed in outline as far as that province is concerned, while sheets 78, 83 and 84 have been brought up to date as regards recent internal territorial changes and are now among the maps set aside until orders as to external boundary symbols are received. New editions of the Provincial maps of Bengal, of Eastern Bengal and Assam in outline, and of the Central Provinces in outline and with hills, have been in hand; the first two have been completed and published, while the last only awaits the approval of the local Government as to boundaries, etc. The maps of the Punjab and the United Provinces on the scale of 1-inch = 32 miles have also been under revision and have been sent to press for proof prior to publication.

42. Forty-three District maps on scales of 1 inch=2 or 4 miles have been brought up to date or completed. Twenty have been published and the remainder are under publication, ten of these are new publications and one is a new edition.

43. Eight of the Burma degree sheets on the scale of 1 inch = 4 miles have been dealt with during the year. The hills for two of these sheets (Nos. 29 and 54) have been brush-shaded for photographic reproduction by an adaptation of the helio-zinco process. One of these (No. 29) has been reproduced with satisfactory results, though the cardboard on which the drawing was made was found, when the work was too far advanced to be rejected, to be of far from good quality. A drawing on better quality cardboard has been made of the hills of sheet 54 and will shortly be ready for press, and if the results are satisfactory it may be advisable to adopt this process for showing the hills on the engraved sheets when they are prepared, as the effect is good and by this process the hill plates could be prepared in about a quarter the time it would take to engrave them. Sheets Nos. 29, 31 and 67 have been completed and published, the remaining five are under publication in various stages and will shortly be available.

44. Six hundred and eighteen standard sheets have been dealt with during the year, the majority are as usual reprints and of these 225 have been

published. Thirty-five Administration Report maps on the scale of 1 inch = 8 miles were dealt with, all but one being reprints.

Of plans and maps of cities and cantonments 133 sheets have passed through the office, a large number being those of the Rangoon town survey. Nineteen sheets of the large scale Calcutta survey have been revised and published, while the 6-inch map has been partially revised, rearranged, and sent to press for proof; but such revision as can be made by this office must always be more or less unsatisfactory, and thorough professional revision is most desirable bearing in mind the great changes that are always occurring in the city.

45. The preparation of the new series of Index maps to illustrate the degree and standard sheets falling within each of the $\frac{1}{M}$ series has been steadily prosecuted during the last half of the year. Of these two, Nos. 34 and 84, have been completed and a limited number of copies published for departmental use, while 12 more are far advanced towards completion and should shortly be available. A large number of other index maps have also been dealt with for various purposes during the year.

46. Seventeen triangulation or traverse charts have been passed through the office, some necessitating a large amount of work. Owing to the press being unable to cope with the type work connected with these, a commencement has been made to insert the letterpress by hand, and it is hoped some more may shortly be got ready for publication in this way.

47. As usual a large amount of work has been performed for other departments, Military, Foreign, Public Works, Postal, etc. The Postal maps of the various circles continue to form a very heavy piece of work; those of the Central and United Provinces have been published during the year, while those of Bombay, Madras, and Eastern Bengal are well in hand, the first having reached the proof stage, but as numerous alterations were made when the map was in that stage it had to be reproduced a second time. A very troublesome piece of work, namely, the preparation of the Agency maps of Central India, is gradually being completed in spite of the constant corrections and additions made on the proofs. Manœuvre maps for the various commands form a never-ending source of work, and it would be well if officers requiring these could look more ahead, as it is impossible to satisfy all applicants at once, and the maps of the various areas affected are generally wanted at the same time of the year and urgently. A series of maps for the various Provincial Gazetteers has also been under preparation as opportunity offered, and will continue for some time to come to tax our drawing power.

48. The Examining Section of the office has passed 1,884 sheets and has besides provided a large amount of geographical information to various officials and performed much other miscellaneous work. This section is not strong enough to cope with the work demanded of it.

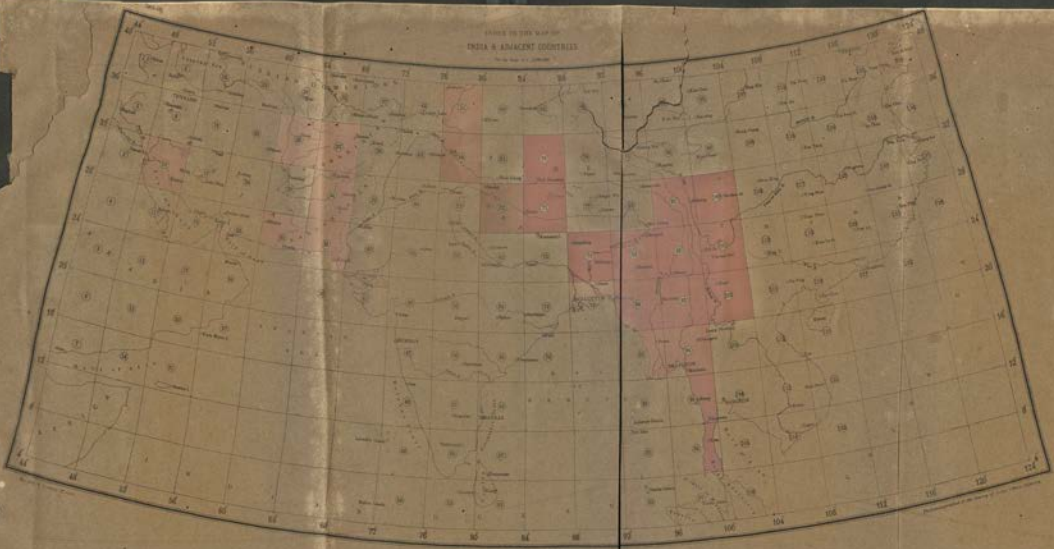
49. A total of 1,803 pages of traverse data have been copied and examined by the Computing Section for local or district officers, as usual the majority of the demands being from Burma. There has besides been the usual miscellaneous compilation work. The number of applications received from private individuals for copies of old records, etc., was 1,035, in response to which 1,566 authenticated copies were issued and for these the Government fees paid over to the Account Section amounted to R940-4-0.

50. Twenty-nine thousand two hundred and ninety-five coloured copies of maps were examined and passed for stock or issue. Six hundred and eight sheets were coloured for the office records, and 3,960 were corrected and certified to after correction.

51. *Engraving Office.*—Owing to the recommendation of the late Survey Committee that the compilation of the sheets of the Atlas of India should be discontinued, the engravers have mostly been employed on the new pattern index maps and degree sheets, as well as on the general maps of India and miscellaneous work.

Atlas sheets No. 41 N-W, 60 S-W, 80 S-W, and 106 S-W, have been published during the year. Corrections have been made on ninety others, in order that they may be available for printing when required.

Five more quarter atlas sheets, Nos. 20 S-W, 89 N-E and N-W, 106 N-E, and 107 N-W, still remain to be completed for publication. A few more plates also require to have corrections finished off.



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On the completion of the above no more work will be done on the plates of the old Atlas of India.

Six of the new degree sheets which are to take the place of the atlas sheets have been projected. An experimental sheet has been commenced on three plates, but the work had to be suspended until material was available for the additional longitudinal strip of 2′ 27″, due to the adoption of the latest value of the longitude of Madras for our maps. This material only came to hand late in the year, when work was at once resumed. It is proposed to complete this sheet as early as possible, and after all details on it have been approved of, work on other sheets, for many of which it is hoped complete material will shortly be available, will form the main work of this section.

A sample standard sheet of the new pattern has also been in hand during the year. This has been engraved on four plates for reproduction in colours. The engraving of the detail has been practically completed. There has been considerable delay over this sheet as the hill work was found on completion to have been cut too deep, and required considerable toning down, while some lettering also required alteration.

The sheet has been further delayed owing to the characteristic symbols to appear on each sheet not having been finally approved. Orders on this point have however now been passed and the plates will be completed as early as possible.

It is yet uncertain if more of the standard sheets are to be engraved.

A new 32-mile map of India in 12 sheets will be shortly commenced, and the projection of the plates is well in hand.

Work on the duplicate 64-mile map of India, which has been brought up to date as far as possible and in particular on the North-West and North-East Frontiers, has been carried on throughout the year. The plates are now practically ready for printing, but orders are awaited regarding the external boundary symbols. As soon as an edition has been printed off, it is intended to alter the meridian lines, adopting the meridian of 80° as the central one, so that each quadrilateral formed by the intersection of the meridional lines with the latitude parallels will embrace the area of one of the sheets of the India and adjacent countries series. It is intended at the same time to insert a finer symbol for the railway lines than exists at present, revise boundary symbols, etc., and in many ways bring the map more up to date. One plate has already had a matrix taken and certain corrections have been carried out. A considerable amount of work has also been done on the engraved plates of the 96, 128 and 192-miles=1 inch maps of India.

During the year work has been carried out on the 1-inch=16 mile maps of Bengal, Bombay (new), Gujarát, Madras (new) and Punjab. These plates have been for long in hand and are being completed for publications.

Nine plates for the new index maps to the standard and degree sheets falling in each $\frac{1}{M}$ sheet have been prepared, and dry prints have been supplied to the Drawing Office for the entry of the detail required. These index maps will in the first instance be prepared by helio-zincography, but eventually they will probably be engraved. Thirty-nine District maps, four Weather Charts, three of the plates of the Calcutta maps, thirteen scale plates, and twenty other miscellaneous plates have been worked upon. Four new forms in English and Urdu for commissions in the native army have had to be engraved, as it was found impossible to make the required alterations on the old plates. These will occupy the engravers for some months to come. Eighteen photogravure plates have had titles cut on them, while a photogravure map in two large plates of the Goa territory on the scale of 2 inches=1 mile has required much retouching to prepare it for printing. The Copper-plate Printing Section pulled 45,143 impressions, an increase on last year's total of 1,693 pulls.

In the Steel-facing Section 355 plates were dealt with, and 46 plates were corrected from the surface and filled in by electro-deposition.

During the month of April, a serious theft of copper-plates, sixteen in number, took place in the office. Apart from the value of the copper stolen, the loss is luckily small, as most of the plates had been either just commenced or contained small areas of country only. The most serious losses are Atlas Sheet No. 51 N-W, and two plates of the old so-called Lottery Map of Calcutta. The first will shortly be replaced by an etching on copper from an impression obtained from a print by

the Vandyke process. No clue to the perpetrators of the theft has been discovered, though the police have made enquiries in all likely quarters and offered a reward. The almirahs which were formerly constructed, more for the object of preserving the plates from disarrangement than for safety, have been strengthened, and precautions are daily taken to see that all plates are locked up before the office is closed.

52. *Photographic and Lithographic Office.*—The total number of prints of maps, plans, diagrams, etc., for the Survey of India and for other departments shows an increase of 20,265 over that of the previous year. The total number of copies printed being 932,614 as against 912,349 in 1904-05.

There was a slight falling-off in the number of cadastral maps printed, the figures being 45,490 as against 58,875.

There has been a decided improvement in the class of originals sent in by outside departments for reproduction and this has enabled more extra-departmental work to be undertaken.

53. The following were the more important departmental publications of the year:—

Three hundred and six standard sheets of which 68 were in black and brown. The total number of copies printed from these sheets was 76,221.

Forty-two District maps of which 10,410 copies were printed.

A map of India on the scale of 1 inch=64 miles.

A new sketch map of Bengal, 1 inch=32 miles.

A map of Eastern Bengal and Assam, 1 inch=32 miles.

A map of Eastern Bengal and Assam in five colours, 1 inch=12 miles.

A map of the Madras Presidency, 1 inch=32 miles.

A map of the United Provinces in two colours, 1 inch=16 miles and a map of the Bombay Presidency, 1 inch=32 miles.

Forty sheets of the Calcutta survey were corrected and 200 copies of each printed.

Twenty-two sheets of the Delhi Hissar Revenue survey, of each of which 150 copies were printed.

A map of the Aden survey, Steamer Point cantonment, and a cantonment plan of Ahmedabad.

The new 32-mile map of India with hills in brown has been worked on during the year, further corrections to several of the sheets having been received.

54. The principal extra-departmental items included 60 maps of various kinds for the Foreign Department.

Eleven maps, etc., including the 80-mile map of India showing railway systems in nine colours of which 2,150 copies were printed, and a diagram in seven colours showing capital outlay, gross earnings, etc., of which 1,900 copies were printed for the Railway Board.

Nineteen plans and diagrams and one map in four colours were prepared and printed for the Sanitary Commissioner to the Government of India.

Five thousand seven hundred and eighty copies of 4 maps in colours involving 40,460 runs were printed for the Linguistic Survey, and 247,160 copies of various charts were printed for the Meteorological Reporter to the Government of India.

55. The outturn of the Type Section (1,816,405 prints) is less than last year. The work of the Heliogravure Section has decreased considerably.

Last year it was reported that Mr. Turner had met with considerable success in reproducing a brush shaded hill drawing. These experiments have been continued by Mr. Taylor, who has devised a new method for reproducing a brush drawing and printing direct on to zinc without the necessity for any hand-work. The results are shown in the map attached to this report and may be considered very satisfactory, and it is hoped to make extensive use of this process in future.

The office continues to suffer severely from the lack of high class printers, and it will be absolutely necessary to obtain a better class of printers if the new standard sheets in four colours are to be satisfactorily dealt with.

56. *Map Record and Issue Office.*—Issues during the year amounted to 110,068 sheets of an aggregate value of R1,23,016, which is an increase on last year's totals of 14,704 sheets and of R14,596. Out of this total R18,210 was realized from sales to private individuals.

The number of new maps received on publication was 104, whilst 990 new editions and reprints were received from press for issue. The number of original,

maps, volumes of computations, etc., issued from store to other departments or branches of the office was 4,915 of which 4,755 were received back again.

The transfer of the original cadastral sheets from this office to the various head-quarters of local Governments or districts was completed during the year.

The work of revising the catalogues has again been resumed, and those of the United Provinces and the Punjab are approaching completion, and it is hoped will shortly be ready for issue.

No more forest maps have been transferred to Dehra Dún, as rack accommodation for them is not yet available there.

The work of overhauling and re-registering the fair maps, computation volumes, etc., has been steadily carried on throughout the year, and a fair amount of progress made, but much still remains to be done. The topographical record room has been re-arranged and made much more accessible; while a wall with an iron door has been built entirely closing in the room in which the fair maps of the department are stored, and it is hoped they are now more secure against fire than they were previously. It would, however, be far more satisfactory could all our valuable records be placed in a detached building suitably constructed where they could be better protected from the ravages of vermin and insects, and be still more safe from fire.

57. *Mathematical Instrument Office.*—During the year under report, *i.e.*, from 1st April 1905 to 31st March 1906, there has been a considerable increase in the demands made on this office. For the last three years the value of instruments, etc., issued was R3,64,646, R3,54,005 and R4,22,179, respectively; the value of repairs to instruments received for that purpose and returned in a serviceable condition was R37,449, R40,069 and R41,818 and the value of instruments received from government officers as "no longer required" was R74,066, R85,994 and R76,096.

The book value of the stock of instruments, etc., in the serviceable store at the end of each of the last three years was R3,85,145, R3,92,653, and R4,53,251. In order that this office may be prepared to meet without delay all reasonable demands and in view of the long time that usually elapses after an indent is despatched to the Director General of Stores, before the receipt of the instruments indented for, it is impossible to keep these values low.

The book value of the stock of instruments, etc., in the repairable store at the end of each of the last three years was R1,64,474, R1,46,734 and R1,19,907. Instruments for which there was a demand were not left in the repairable store for any length of time, but were sent to the workshop for repairs and transferred to the serviceable store for issue.

The "profit and loss statement" for the workshop is satisfactory. The number of men and boys employed at the end of each of the last three years was 320, 352 and 421, and the value of the total work done in the workshop during each of these years was R1,50,567, R1,58,958 and R2,01,083. The continued increase in these figures is satisfactory, but, unless the office is removed elsewhere, a limit will soon be reached, for the buildings are already overcrowded and there is very little space available for extensions.

The value of instruments, etc., manufactured in the workshop for the serviceable store during each of the last three years also shows a steady increase, being R57,095, R64,188, and R82,638, respectively. A considerable profit accrues to Government on account of these manufactures, as the instruments, etc., are turned out at a lower price than they can be purchased at and there is no occasion to keep up a large stock of them in the serviceable store. The value of instruments, etc., purchased locally for the serviceable store during each of the last three years was R11,641, R14,405 and R17,810.

The value of instruments, material, etc., obtained from England through the Director General of Stores during each of the last three years was R1,46,509, R1,91,113, and R2,87,740. These amounts are naturally increasing owing to the rise in the values of the issues and in the value of the work done in the workshops.

58. Mr. T. R. Theakston, Mathematical Instrument Maker, died while on leave in Europe, and his post was filled by the confirmation in the office of Mr. T. A. Ferrier who was officiating for him during his absence. Mr. Theakston was a most zealous hardworking officer, and the great increase in outturn and improvement in workmanship is in a great measure due to his energy and initiative.

BRANCH OFFICES, DEHRA DÚN.

59. *Trigonometrical Surveys.*—The superintendence of the Trigonometrical Branch was under Lieutenant-Colonel S. G. Burrard, F.R.S., R.E., during the year. Lieutenant C. M. Browne, D.S.O., R.E., was in charge of the Technical offices up to 27th November 1905, when Mr. J. Eccles, M.A., on return from leave, relieved him, and held the charge for the rest of the year.

Lieutenant F. F. Hunter, I.A., joined on the 27th April 1906, on special duty.

Lieutenants, L. G. Crosthwait, I.A., V. R. Cotter, I.A., and K. W. Pye, R.E., who joined on the 13th and 30th October 1905, and 17th March 1906, respectively, were put through a course of trigonometrical, topographical and astronomical work. Fifteen Sub-Assistant Superintendents were also put through a course of training during the year and one Sub-Assistant Superintendent and six surveyors prepared for exploration work.

60. The following computations were carried out in the Computing Office :—

(*a*) Various pieces of snow peak triangulation in Kumaun and Garhwal between longitudes 79°-0′ to 80°-30′, have been finished with the exception of the heights, as have also Colonel Tanner's Someshwar Series and the Darjeeling revisional survey.

(*b*) The Dehra. Dún and Jaunsar Báwar triangulations are nearly ready for press. The above are all for incorporation in the synoptical volume of the North-East Longitudinal Series.

(*c*) Snow peak triangulations in Western, Eastern and Central Nepal, the Sikkim triangulation peaks observed from the Western border of Sikkim, and the heights of Colonel Waugh's Himalayan peaks with modified co-efficients are now in hand for incorporation in the same volume.

(*d*) Besides the above, computations for investigating the co-efficient of refraction and the deflection of plumb-line were also made.

(*e*) Computations on account of change of origin of the rectangular co-ordinates of the triangulations of Dehra Dún and Deoban and for the projection of a map of Persia were made for the Drawing Section.

(*f*) A number of miscellaneous heights were computed to supply data.

(*g*) The Pendulum results supplied by No. 23 party for the Geodetic Conference were checked.

The printing of the fourth edition of the Auxiliary Tables was completed and the books are being distributed. A pamphlet containing the record of rainfall, etc., at Dehra Dún for the past 36 years was issued. The printing of Volume XVIII of the Great Trigonometrical Survey of India containing Astronomical Latitudes was commenced and is nearly finished.

During the year fifty-two officers were supplied with data from records in this office.

The comparison and examination of press proofs were carried on and the care of the records, library and printed papers as well as the meteorological observations were continued as usual.

The necessary professional aid in connection with the protection of stations was rendered by the Computing Office to the office of the Superintendent, Trigonometrical Surveys. Six hundred and seventy-five stations were repaired at a cost of R3,651-15-9 by the district officers. Out of 333 districts from which the reports are annually due only one failed to make a return.

61. In the Drawing Office the following maps were drawn either totally or partly and sent to press :—

(1) Three Tibet maps, scale 2 miles=1 inch; and one, scale 100 yards=1 inch.

(2) Nine Sind level sheets.

(3) Three North-East Frontier sheets on scale 8 miles=1 inch.
One North-East Frontier sheet 4 miles=1 inch.
One North Frontier sheet on scale 8 miles=1 inch.

(4) One Sikkim map on scale 4 miles =1 inch.
One Bhutan map on scale 8 miles=1 inch for the Bengal Government.

(5) Five standard sheets of the United Provinces.
(6) One Punjab sheet on scale ½ mile=1 inch, which involved the drawing of four sheets on the scale of ¼ mile=1 inch, and half a Punjab standard sheet.
(7) Six triangulation charts.
(8) One sheet of the Map of India and Adjacent Countries.
(9) A number of diagrams to illustrate a book on Himalayan geography.

While the following are nearly ready for press:—
(1) One standard sheet of the United Provinces.
(2) Eleven Sind level sheets.
(3) One North-East Frontier sheet, scale 16 miles=1 inch.

And the following are still in hand:—
(1) Three sheets of the Map of India and Adjacent Countries.
(2) Index Route Map of the Western Himalayas.
(3) Map of Persia, scale 40 miles=1 inch.
(4) One standard sheet of the United Provinces.
(5) Three level sheets in Sind and one in the Punjab.
(6) A special map for the Foreign Department prepared under the direction of Lieut. F. F. Hunter, I.A.

Headings, footnotes including symbols and area statements, were completed on 224 maps which were also sent to press.

Two thousand seven hundred and sixty maps were coloured.

Nine hundred and eighty-three maps and diagrams were photographed against 1,099 during 1904-05, and 108,064 pulls taken against 85,066 in the same period.

Photographs of the sun were taken on 300 days.

62. *Forest Surveys.*—The offices of this branch were under the superintendence of Major P. J. Gordon, I.A., Superintendent of Forest Surveys, throughout the year, and in addition to the ordinary routine work were employed on the upkeep of the map records of the Forest department, and on the compilation of special working plan, and other maps sanctioned by the Inspector General of Forests.

During the year 248 maps were published at Dehra Dún and Calcutta and 138 at the Government Photo-Zincographic Office at Poona.

Eleven thousand six hundred and twenty-nine printed maps were issued, of which 8,304 were coloured and 2,642 mounted in book form.

There was a considerable demand for forest maps by the public interested in the mining and timber trades, as well as by officers of the railway and canal departments, and a sum of R858 was realized during the year by their sale.

Good progress has been made in providing racks for storing maps and it is hoped that accommodation will soon be available for storing the remaining forest maps now in the Calcutta Office.

LOCAL DRAWING OFFICES.

63. *North-West Frontier Drawing Office.*—The principal work of this office during the year has been the preparation of small scale maps of the North-West Trans-frontier series. Of the fourteen sheets of this series on the scale of 1-inch=4 miles on which the office has been employed during the year, 13 have been sent to press, six sheets on the same scale of the South-West Asia series have also been sent for publication, and one of the Northern Trans-frontier series. The six sheets of the map of "India and the Adjacent Countries" are almost ready for publication.

Personnel.

Captain F. W. Pirrie, I.A., Deputy Superintendent, 2nd grade, in charge till 15th October.
Major C. L. Robertson, C.M.G., R.E., Deputy Superintendent, 1st grade, in charge from 16th to 20th October.
Mr. R. R. Dickinson, Extra Assistant Superintendent, 1st grade, in charge after 20th October.
Mr. W. S. Cornelius.
Mr. F. E. Warde, Sub-Assistant Superintendent, 1st grade.
Mr. H. Sindon, draftsmen.
19 draftsmen, etc.

The miscellaneous work has included the reduction and plotting of portions of Dr. Sven Hedin's routes from Tehran to Seistan, the preparation of duplicate computations for No. 15 Party and the colouring, examination, and correction of a large number of maps on various scales.

The total cost of the office during the year has been R24,960.

This office will be absorbed in the office of the Superintendent, Frontier Surveys, during next year and its work will be continued there on similar lines to those reported above.

64. *Burma Drawing Office.*—This office is located at Bangalore and is employed mainly on the compilation of degree sheet maps, but much miscellaneous work in connection with Burma surveys is also done. Mr. W. Stotesbury (late of the Survey of India) held charge until the 11th June 1906, when he was relieved by Mr. T. Shaw, Extra Deputy Superintendent, 1st grade, who was transferred from Assam. The subordinate establishment consisted of 19 draftsmen of whom 10 were transferred temporarily to field parties during the recess season to assist in standard mapping. Sheets 85N, 93H and 93K were completed and sent to Calcutta for publication and sheets 84P, 85N and 93K were published. The following sheets of which the survey has been completed are in hand:—84L, 85M, 93L and 94A. The drawing of sheets 85O, 93P and 94C has also been commenced, but the survey of these sheets has not been completed yet. The drawing of sheet 94B, the whole of which has been surveyed, will be taken up next season. Nine standard maps of No. 10 Party of season 1904-05 were completed in this office, four standard sheets which had been published in the old form were redrawn in the new form, and all were forwarded for publication. The degree sheet mapping will be continued next season and the arrears of No. 3 Party's 1-inch mapping will be handed over to this office for completion.

65. *United Provinces Drawing Office.*—This office was formerly attached to No. 8 Party which was broken up as mentioned at paragraph 248 of last season's report. Mr. J. Kennedy, Extra Assistant Superintendent, 2nd grade, continued in charge and was assisted by Mr. W. C. Price, late Survey of India, who was temporarily re-employed to push on the standard mapping which is being compiled from the cadastral surveys of the province. Mr. Price resigned in April 1906 and Mr. F. S. Bell, Extra Assistant Superintendent, 4th grade, was attached to the office till the end of the season, when he was transferred to a topographical party. The subordinate establishment consisted of 35 draftsmen, 3 typers and 2 computers. Fifteen standard sheets were completed, seven were forwarded to Calcutta for publication and 11 were published during the season; nine other sheets are in hand. Eleven traverse charts were completed and four were forwarded for publication but none have yet been published.

ESTABLISHMENT.

66. During the year the department has lost the services of Major H. A. D. Fraser, R.E., who is now employed under the Kashmir Durbar.

The following military officers were appointed to the department during the year:—Lieutenants L. G. Crosthwait, I.A., H. J. Couchman, R.E., O. H. B. Trenchard, R.E., S. W. S. Hamilton, R.E., V. R. Cotter, I.A., and K. W. Pye, R.E.

67. In the Provincial service seven officers have retired—Messrs. R. F. Warwick, J. S. Swiney, W. Robert, A. W. Smart, C. P. Torrens, F. E. Warde, and Munshi Ikbaluddin, K.S.; three have resigned—Messrs. P. Samuels, F. C. Glass and Babu H. N. Mukharji; and two have died—Messrs. C. S. Gasper and G. W. Archer. Sixteen (probationary) appointments to the Provincial service have been made during the year.

68. The Gold Medal of the Paris Geographical Society has been awarded to Major C. H. D. Ryder, D.S.O., R.E., for his valuable additions to the geography of Tibet and of the sources of the Brahmaputra.

In recognition of their services, while employed with the Seistan Arbitration Commission, the Government of India has been pleased to sanction a special personal allowance of R200 per mensem to Mr. G. P. Tate, and rewards of R500 to Surveyors Kadir Sharif, Gopal Singh, R.B., and of R300 to Surveyor Jamal-ud-din.

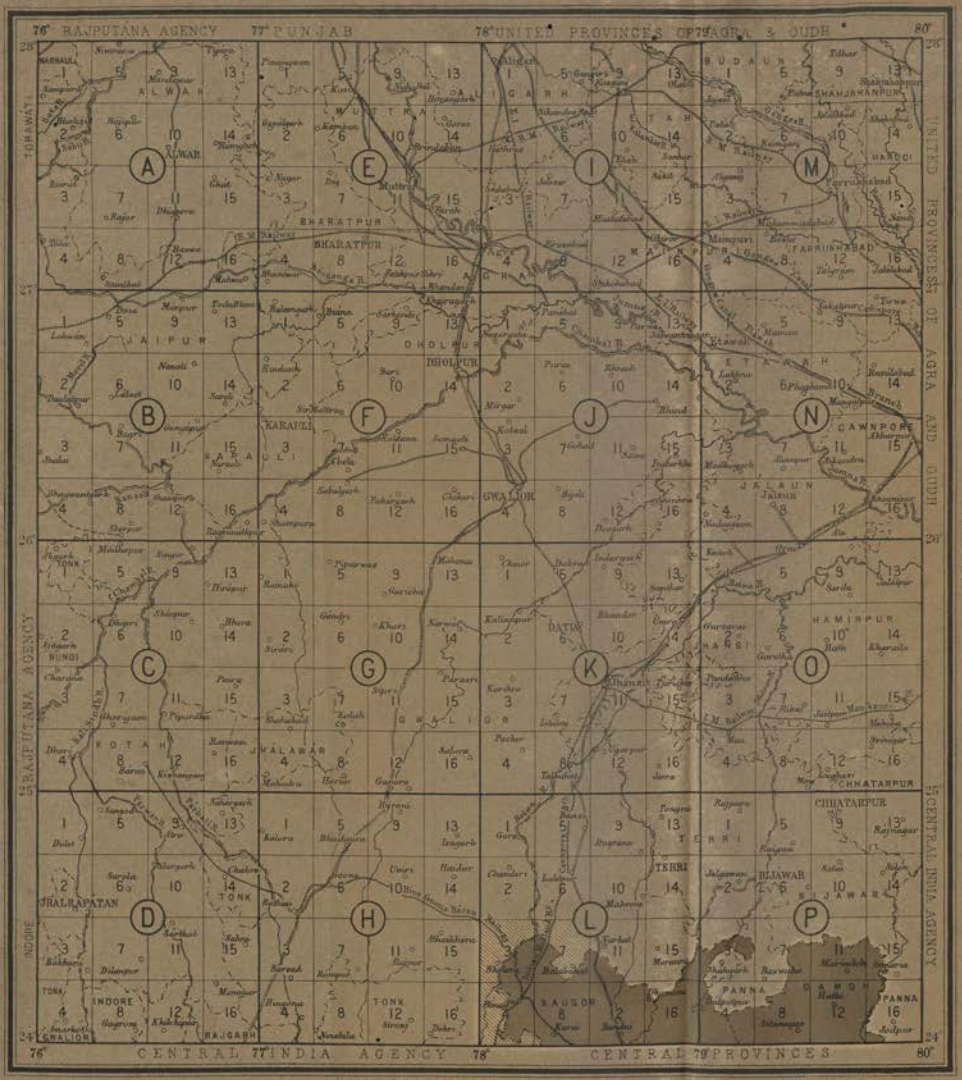
SHEET No. 64.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF SURVEYS BY THE TOPOGRAPHICAL SURVEYS.

1905-06.

Communicated Sheet. 563



NOTE.

THE NUMBER IN THE HEADING IS THAT OF THE SHEET OF THE INDIA AND ADJACENT COUNTRIES SERIES ON THE SCALE OF 1 INCH TO 1 MILE.

THE LETTERS PREFIX THE DEGREE SHEETS ON THE SCALE OF 1 INCH = 4 MILES CONTAINED WITHIN THE ABOVE WHILE THE SMALL FIGURES PREFIX THE NUMBERS OF THE 1 INCH SHEETS CONTAINED IN EACH DEGREE SHEET.

WHEN ORDERING A SHEET ON THE LITHO SCALE GIVE THE NUMBER GIVEN IN THE HEADING FOLLED BY THE DEGREE SHEET LETTER AND NUMBER e.g. 57 D 3. IN THE CASE OF A DEGREE SHEET THE NUMBER IN THE HEADING AND THE DEGREE SHEET LETTER MUST BE GIVEN e.g. 57 D. FOR A 1 INCH SHEET THE NUMBER IN THE HEADING THE DEGREE SHEET LETTER AND THE 1 INCH SHEET NUMBER MUST BE QUOTED e.g. 57 J 7.

Published under the direction of Colonel F.B. Longe, R.E., Surveyor General of India

1907

Scale 1 Inch = 28 Miles.

INDEX TO ADJOINING SHEETS.

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45	54	63
46	56	64

REFERENCES.

1. DEGREE SHEETS PUBLISHED ON THE 1 INCH SCALE
2. DEGREE SHEETS IN HAND ON THE 1 INCH SCALE
3. 1901
4. SURVEYED IN 1904-05
5. SURVEYED IN 1905-06

No. 161. S. I.—May 07.—500.

Reg. No. 271-S. '07.

Map. S. I. O., Calcutta.

PART II.

THE OPERATIONS OF FIELD PARTIES.

TOPOGRAPHICAL SURVEYS.

CENTRAL PROVINCES, UNITED PROVINCES, AND CENTRAL INDIA AGENCY.

No. 1 PARTY.

69. The party was mainly occupied this season in completing standard sheets of which the Central Provinces portion only had been surveyed in recent years, and the greater part of the area surveyed consisted of territory of the States of the Central India Agency of which a topographical survey had been done on the 1-inch scale between 1854 and 1872 This was re-surveyed on the 2-inch scale, while the work in the Central and United Provinces consisted of supplementary topographical survey, also on the 2-inch scale, of ground surveyed cadastrally many years ago by local agency and traversed by the Survey of India. An attempt is being made to carry out the present survey with the aid of the triangulation and traversing of the old surveys, which have not proved altogether adequate. Some of the trigonometrical stations cannot be found, heights are wanting in others, even in the work of the Great Trigonometrical Survey; intersected points cannot now be identified, discrepancies exist in the various former surveys topographical, forest and cadastral; traverse stations and trijunction mar.... have disappeared and finally the old survey of Central India having been done on the 1-inch scale, the triangulation is not sufficient for the larger scale now employed. A considerable amount of triangulation and traversing has consequently to be done now, and this season 60 linear miles of simple traversing was done and 550 square miles of triangulation with observations at 19 stations whereby 10 new stations were fixed.

Personnel.

Captain A. H. B. Hume, R.E., Deputy Superintendent, 2nd grade, in charge.
Mr. W. Skilling, Extra Assistant Superintendent, 4th grade.
Mr. F. P. Walsh, do. do. 5th „
Mr. W. J. Newland, do. do. 6th „
Mr. B. M. Berill, Sub-Assistant Superintendent, 1st grade.
Mr. R. E. Saubolle, do. do. 2nd „
Mr. F. C. Glass, do. do. 2nd „
55 Surveyors.

70. Field work commenced on the 21st October 1905 and closed in the early part of May 1906 during which time the health of the party generally was good. In the sheets lying to the north the country was mostly flat and open with occasional rocky hills covered with thin jungle, while to the south, especially in the Bhopal State, it was hilly and forest clad. The valley of the Nerbudda river, a portion of which again came under supplementary survey this season, was described in last year's report. The outturn of detail survey was 2,086 square miles scattered over 16 standard sheets. This is a very small outturn for so many surveyors, but many of these were new or partially trained men who had been drafted into the party for further training from the parties employed on the north-west frontier where the training of surveyors is out of the question, and 7 were native soldiers also under training. The average outturn *per* man was 0·38 square miles *per* working day; the average number of plane-table fixings *per* square mile was 28 and of clinometer heights 4·2.

71. Several large forest reserves in the Central Provinces, that had been surveyed some seasons back by the Forest Survey, fell into this season's work, but owing to insufficiency of trigonometrically fixed points, it was found impossible to carry out the necessary examination of the maps to bring them up to date and into accordance with the new work and this will be done next season, when the necessary data will be obtained by traversing. This however prevents the completion of several sheets at present. The cost-rate of the detail survey was R25·3, but this does not include the work done in connection with the

reduction of the cadastral maps nor the fair mapping, both of which include areas not surveyed this season. The cost of the former operation was ₹7·4 *per* square mile and that of the latter ₹12·9.

72. The traversing of village boundaries for the Settlement Department was continued and 43 villages were traversed in Nimar, Balaghat and Saugor districts involving 213 linear miles of chaining.

73. As it has now been ordered that all standard sheets are to be surveyed up to graticule limits many of the maps of former seasons cannot be published, the survey having been confined to the Central Provinces, and again this year it has not been possible, as explained at paragraph 71, to despatch all the season's maps for publication. The drawing of all that was surveyed was however completed and four sheets in the new form and one in the old were sent to Calcutta. Seven sheets were published during the season. The Surveyor General inspected the party during the recess and the Deputy Surveyor General during both the field and recess seasons.

74. Next season the unfinished sheets of this season's programme will be completed, the area being 690 square miles including the forest areas, and an endeavour will be made to complete the following 15 standard sheets $54\frac{L}{11,\ 15,\ 16}$, $54\frac{P}{3,\ 4,\ 7,\ 8,\ 11,\ 12,\ 15,\ 16}$, $64\frac{A}{1,\ 5,\ 13}$, containing an unsurveyed area of 1,557 squar miles. All of these sheets were partially surveyed a few seasons ago. The personnel of the party however still remains the same and there is so much miscellaneous work in connection with the work of former seasons to be done that it is doubtful if this programme, small as it is, will be completed.

CENTRAL PROVINCES AND BERAR.

No. 2 PARTY.

75. The instruction of newly appointed officers of the Imperial and Provincial services was continued in this party, and the topographical survey of Berar on the scale of 2 inches to the mile was carried on in continuation of last season's operations. Field work commenced on the 16th October 1905 and closed on the 8th May 1906.

Personnel.

Mr. C. F. Erskine, Officiating Superintendent, 2nd grade, in charge, till 27th December 1905.
Captain H. Wood, R.E., Officiating Deputy Superintendent, 2nd grade, in charge, from 28th December 1905.
Lieutenant H. S. Couchman, R.E., Assistant Superintendent, 2nd grade, from 30th January 1906 to 21st September 1906.
Lieutenant S. W. S. Hamilton, R.E., Assistant Superintendent, 2nd grade, from 14th January 1906.
Mr. C. J. Veale, Extra Assistant Superintendent, 6th grade.
18 Junior provincial officers.
5 Soldier surveyors.

The minor series of triangulation begun last season was continued for a length of about 50 miles and closed on the Khanpisura Meridional series of the G. T. Survey. The network triangulation done during the season covered 1,850 square miles and the average number of square miles to each point trigonometrically fixed is 2·9.

76. The detail survey of four sheets was completed together with a strip of country 2½ miles wide along the eastern margin of sheet $55\frac{L}{8}$, necessitated by the correction recently applied to the longitudes in India, the area surveyed being 1,124 square miles. Most of sheet $55\frac{K}{5}$ consists of the Wardha district of the Central Provinces, but the rest of the area surveyed this season falls into Berar. It comprised the valleys of the Wardha and Purna rivers and consisted of undulating plains with low bare hills here and there. The outturn given above does not include an area of 33 square miles of reserved forests of the Central Provinces which had been previously surveyed on the 4-inch scale and was not re-surveyed. All the forests met with in Berar not already surveyed by the Forest Survey Branch were mapped on the 2-inch scale. The average monthly outturn of plane-tabling *per* man was 9·3 square miles and the average *per* working day 0·5. The average number of plane-table fixings *per* square mile was 23·9 and of clinometer heights 6·1.

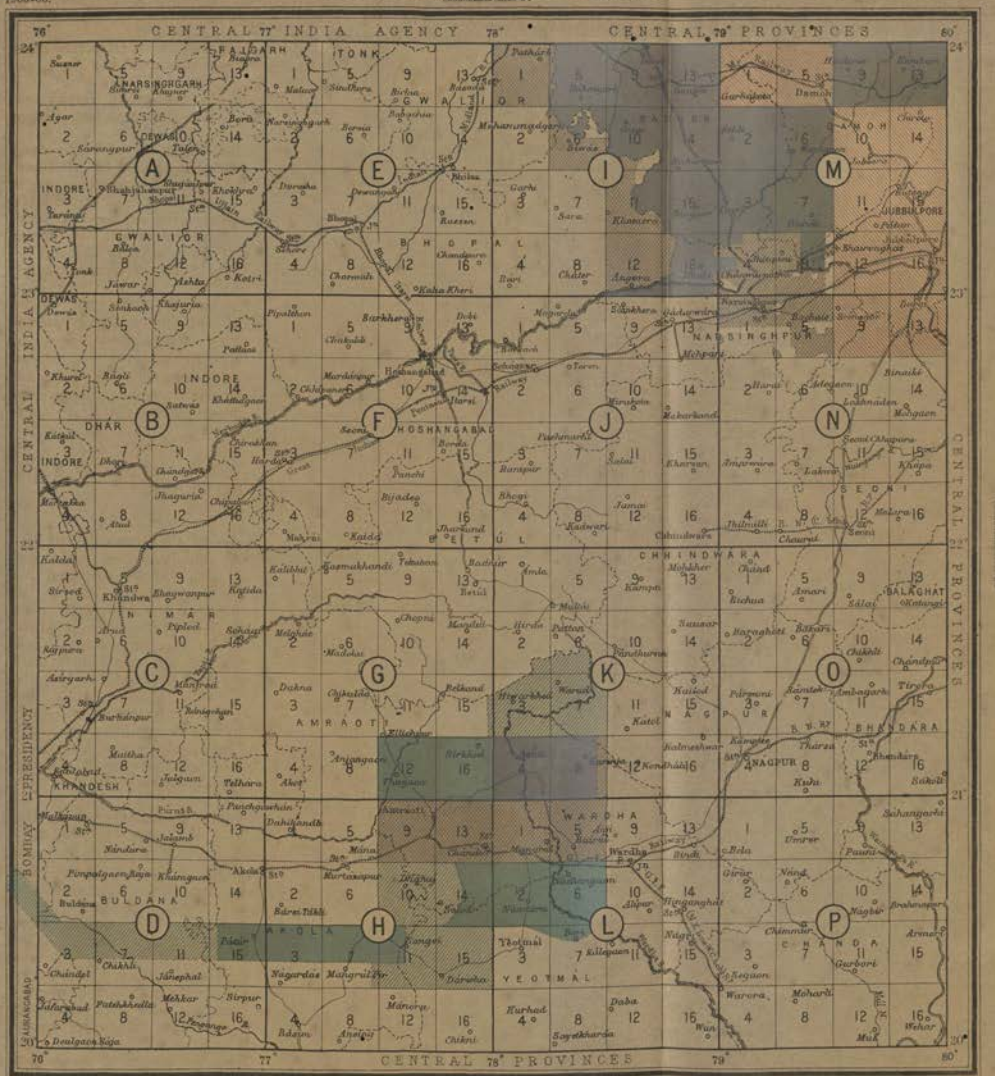
77. The mapping of the arrears left over from the preceding season and that of 3 sheets of the present season's work was completed and submitted for publication. The mapping of the fourth sheet was very nearly completed, as were the whole of the computations of the triangulation, although the recess

SHEET No. 55.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06. Continuation Sheet 54



NOTE.

1. The number in the heading is that of the Sheet of the India and Adjacent Countries Series on the Scale of 1:253,440.
2. The letters denote the Degree Sheets on the Scale of 1 Inch = 8 Miles contained within the above, while the small figures denote the numbers of the 1 Inch Sheets contained in each Degree Sheet.
3. When ordering a Sheet on the 1:253,440 Scale, only the number used in the heading should be used, *e.g.* No. 55. In the case of a 1 Degree Sheet the number in the heading and the Degree Sheet letter must be given, *e.g.* 55 I. For a 1 Inch Sheet, the number in the heading, the Degree Sheet letter, and the 1 Inch Sheet number must be quoted, *e.g.* 55 I.

Published under the direction of Colonel F.B. Longe, R.E., Surveyor General of India.

1907.

Scale 1 Inch = 28 Miles

INDEX TO ADJOINING SHEETS

45	54	63
46	55	64
47	56	65

REFERENCES.

1. Degree Sheets published on the 1 Inch Scale.
2. Sheets published in the style of the 1 Inch Scale.
3. Triangulated or Advanced.
4. Being Year under Report.
5. Surveyed.
6. Previously surveyed but not published.

Sheets 1, 2 and 3 approximately overlap the limits shown by Index.

Reg. No. 241-S. 07.

SHEET No. 84.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.

Conversation Sheet 84.

Conversation Sheet 85.

Conversation Sheet 86.

Published under the direction of Colonel S.G. Lodge, R.E., Surveyor General of India.

1907.

Scale 1 Inch = 20 Miles

Miles 0 5 10 15 20 25 30 35 40 45 Miles

INDEX TO ADJOINING SHEETS

84	85	102
85	84	103
86	85	104

REFERENCES

1. Indian Sheets published on the 1 Inch Scale.
2. Sheets published in new style on the 1 Inch Scale.
3. Sheets [illegible] on the 1 Inch Scale.
4. Sheets [illegible] on the 1 Inch Scale.
5. Sheets [illegible] on the 1 Inch Scale.
6. Sheets [illegible] on the 1 Inch Scale.
7. Sheets [illegible] on the 1 Inch Scale.

Reg. No. 304-S. 07.

Made by L. C. Cousins

season was very short and half the officers were transferred to other parties in the middle of it. The party was inspected both during the field and recess seasons by the Deputy Surveyor General.

78. Next season the triangulation of sheets $55\frac{H}{4,8,12,16}$ will be taken up and the detail survey of sheets $55\frac{H}{10,11,14,15}$.

LOWER BURMA.

No. 3 PARTY.

79. This party was employed as in former seasons on a topographical survey on the scale of 1 inch to a mile, based on triangulation combined with a supplementary topographical survey of such areas as have been surveyed cadastrally and also, to a certain extent, of forest reserves that had been previously surveyed. The season's outturn and cost-rates are as follows :—

Personnel.

Mr. E. F. Litchfield, Deputy Superintendent, 1st grade, in charge.
Mr. W. M. Gorman, Extra Assistant Superintendent, 5th grade.
Mr. J. O'B. Donaghey, do. do. 6th „
Mr. E. Claudius, Sub-Assistant Superintendent, 1st grade.
Munshi M. Asmatullah Khan, do. 2nd „
Mr. H. D. W. Stotesbury, do. 3rd „
28 Surveyors, draftsmen, etc.

	Square miles.	R
Triangulation	3,731	7·5
New detail survey	1,594	21·6
Supplementary survey of cadastral area	2,096	14·1
do. do. of forest reserves	140	

The number of square miles to each point fixed by the triangulation is 10·2. The supplementary survey was done on tracing prints as explained in last year's report. The work done on the maps of the previously surveyed forests consisted merely of the addition of new roads and extra clinometer heights. Owing to the recent change in longitude a strip of country had to be surveyed for addition to the eastern margins of 3 of last season's sheets and of some of the sheets lying to the west of those surveyed this season, while in others the survey had to be carried still further as the previous surveys being Forest work had not been carried to the margins of the sheets.

80. The recess office, at Bangalore, closed on the 16th November 1905 and re-opened on the 16th May 1906 and field work was actually in progress for five months. The number of surveyors was 16, excluding 4 who were under training, and the average outturn *per* man *per* working day was 1·5 square mile of new survey and 2·5 of supplementary. The average number of plane-table fixings *per* square mile was 6·9 for new survey and 7·6 for supplementary. The vertical interval employed in the contouring this season was 100 feet except in sheets $94\frac{A}{1,2}$ where it is 50 feet. The number of clinometer heights fixed was 3,078, which together with the heights provided by triangulation and bench-marks gives an average of 1 height to every 1·2 square miles. The new detail survey this year was confined entirely to the western slopes of the Paunglaung range of hills of which the highest point, 8,607 feet above mean sea level, falls into this season's work. The higher hills were bold and steep, with fairly open tops but the valleys and lower spurs were thickly wooded.

81. The cost-rate for new detail survey is slightly below the average of the past three seasons and that of the supplementary survey is R4 less than last season's, but it includes work done in the forest areas which was, as explained above, of a very simple nature.

82. The fair mapping of the season's work was not completed but the whole of the mapping that remained unfinished at the close of last season was completed and despatched to Calcutta for publication. The work is being carried on in the drawing office at Bangalore and it is hoped that the maps will all be completed by the time the party returns to recess quarters, they are being drawn on the $1\frac{1}{2}$-inch scale, the details having been enlarged by pantagraph from the field maps. Two triangulation charts were despatched to Calcutta for publication. The Deputy Surveyor General inspected the party during the recess.

83. The programme for next season consists of the triangulation of sheets $94\frac{C}{11,12,15,16}$ and $94\frac{G}{1,2,3,4,5,6,7,8}$ and the detail survey on the 1-inch scale of degree sheet 94 F, an area of about 3,000 square miles.

UPPER BURMA.

No. 10 PARTY.

Personnel.

Captain A. A. McHarg, Offg. Deputy Superintendent, 2nd grade, in charge.
Mr. R. Waller-Senior, Extra Assistant Superintendent, 3rd grade.
Mr. P. J. Barrington, Extra Assistant Superintendent, 4th grade.
Mr. W. G. Jarbo, Extra Assistant Superintendent, 6th grade.
Mr. C. West, Sub-Assistant Superintendent, 1st grade.
Mr. E. M. Kenny, Sub-Assistant Superintendent, 2nd grade.
Munshi Abdul Rahim, K.S., Sub-Assistant Superintendent, 2nd grade.
16 Surveyors, etc.

84. The party continued work in Upper Burma on the scale of 1 inch to the mile in continuation of that of former seasons. Field work was in progress from about the beginning of December 1905 to the end of May 1906, the programme was completed and the outturn and cost-rates for the season are as follows:—

	Sq. miles.	Cost *per* sq. mile.
Triangulation	2,815	R 9·3
Detail survey, new	2,323	R 22·4
„ „ supplementary	1,016	R 20·2

85. The triangulation occupied two Provincial officers and one surveyor for nearly 5 months. The greater part of the area triangulated was heavily wooded and about half of it was devoid of prominent points and extremely difficult to triangulate; in two sheets triangulation was impossible and these were thoroughly traversed to furnish both fixed points and heights. The number of stations observed at in the triangulation was 94, the number of stations fixed was 74, intersected points 420, and the average number of square miles to each point and height was 5·6. The traversing occupied one Provincial officer for nearly two months and two surveyors for the whole field season; the outturn was 410 linear miles and 2,055 stations were observed at.

86. The average number of surveyors employed on the detail survey was 15 and the average outturn *per* man for the season was 223 square miles, and *per* working day 1·64 square miles of new survey or 1·27 of supplementary survey. The daily outturn of supplementary survey is less than that of the new survey because several surveyors under training were employed on it. The average number of plane-table fixings and heights *per* square mile was 5·7 and 2·7. The Arakan Yoma range of hills occupied the greater part of the area of which new survey was done, it proved to be a very unhealthy tract and several members of the party suffered severely in consequence. The hills ran to a height of 6,550 feet above sea level. Above 3,000 feet they were covered with dense tree forest and below that level with bamboo jungle and in all parts they were sparsely inhabited, the western slopes entirely so. The cultivated area which came under supplementary survey was open and easy but absolutely devoid of water during the dry season except in the immediate vicinity of the Irrawaddy river.

87. All the computations of the triangulation and traversing which were reported to be in arrears last season have now been completed and only 2 charts are now in arrear. The fair mapping of the season's work was also completed as well as the arrears of the previous season. The Deputy Surveyor General inspected the party during the recess.

88. Next season the triangulation of degree sheet 84 M. will be completed and the southern half will be surveyed on the 1-inch scale as well as the 2 standard sheets remaining unsurveyed in degree sheet 84 N., in all about 2,500 square miles.

SHEET No. 88.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

KINDLING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-1906.

NOTE.

1. The numbers in the margins of this or the Index of the India and Adjacent Countries Series on the Scale of 1 inch.
2. The letters shown on the Index Sheets on the Scale of 1 inch = 4 Miles constitute the Index Sheets, while the Small Figures shown the numbers of the 1 inch Sheets contained in each Index Sheet.
3. When obtaining a Sheet on the 1 inch Scale, and the number given in the Index Sheet is 1 or 2, 3 or 4, 5 or 6, or 7 or 8, the Index Sheet letter will be given as 1 inch Sheet the number in the Index Sheet letter and the 1 inch Sheet number must be given as 1 or 2.

Published under the direction of Colonel F. R. Lindge, R.E., Surveyor-General of India.

1907.

Scale 1 Inch = 25 Miles.

Miles 10 0 10 20 30 40 50 Miles

SERIES TO ADJOINING SHEETS.

83	92	101
84	93	102
85	94	103

REFERENCES.

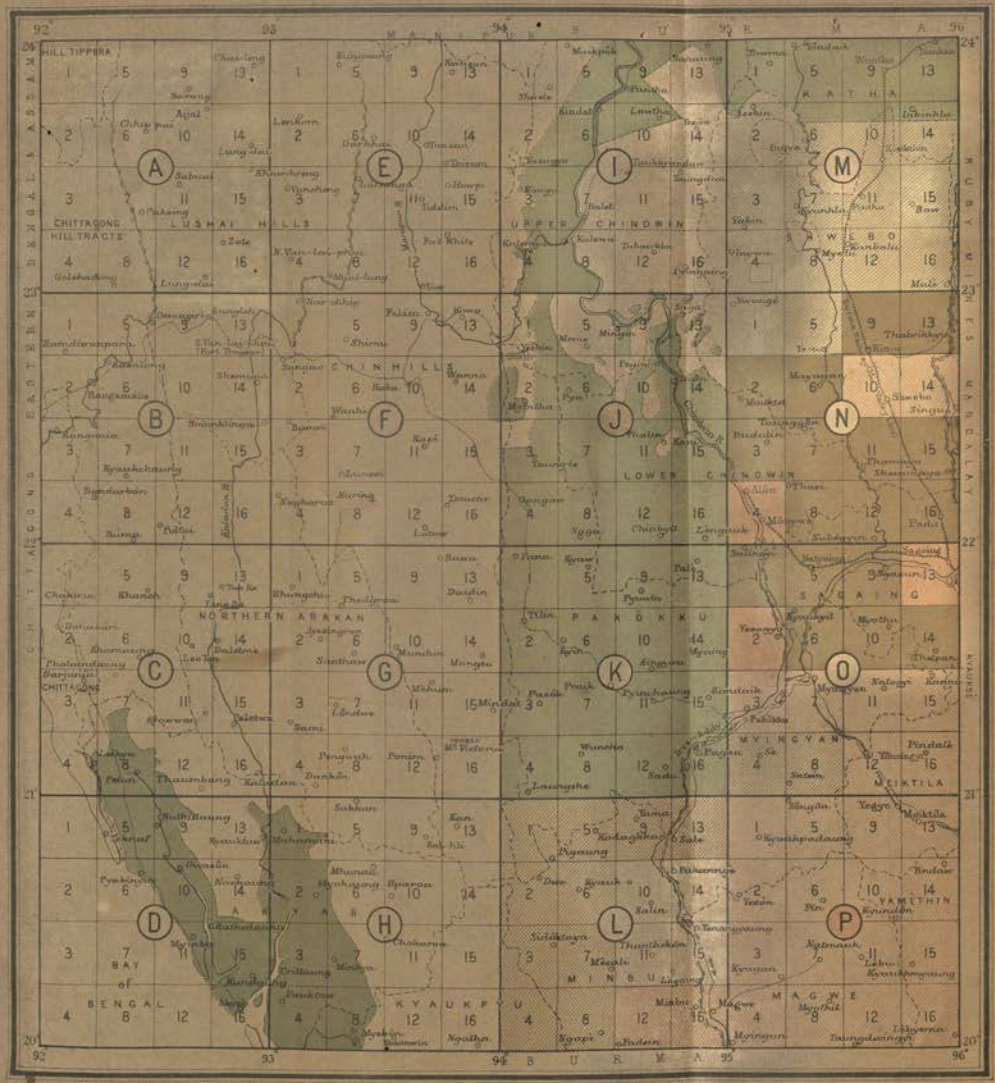
Reg. No. 245-S. 07.

SHEET No. 94.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS.

1905-06.



Published under the direction of Colonel F.B. Longe, R.E., Surveyor-General of India.

INDEX TO ADJOINING SHEETS.

78	83	88
79	84	89
	85	90

Reg. No. 319-S. 07.

SHAN STATES, BURMA.

No. 11 PARTY.

89. This party, much reduced in strength, returned to the Shan States this season to resume the 1-inch survey and instead of returning to Bangalore for recess as hitherto, it remained at Taunggyi, the capital of the Southern Shan States, where it will recess for a few years while the work lies in the extreme east of the States, in order to reduce the immense amount of time lost in returning to India every year. Even from Taunggyi the journey to and from the field occupied from 3 to 4 weeks each way. The party left Bangalore on the 25th October and field work commenced about the middle of December and closed about the 3rd week of April when the programme of detail survey was completed. That of the triangulation was not completed as Mr. Morton, who was carrying it out, fell ill in December and was laid up for a whole month. A sufficient area had however been triangulated in advance in previous seasons to provide a full programme of detail survey for next season.

Personnel.

Lieutenant R. H. Phillimore, R.E., Officiating Assistant Superintendent, 1st grade, in charge.
Babu Pramadaranjan Roy, Sub-Assistant Superintendendent, 1st grade.
Mr. S. S. M. Fielding, Sub-Assistant Superintendent, 1st grade, from 14th May 1906.
Mr. V. W. Morton, Sub-Assistant Superintendent, 1st grade.
14 Surveyors, etc., and 4 Soldier Surveyors under instruction.

90. The season's outturn was 737 square miles of triangulation and 2,078 square miles of detail survey. The number of square miles to each point fixed by the triangulation was 7·6, the average number of plane tablers was 12 and their average outturn 1·42 square miles *per* working day and 161 square miles for the season, which is quite up to the average of former seasons. The average number of plane-table fixings *per* square mile was 6·5. A vertical interval of 100 feet was employed for the contouring except in one sheet which contained the valley in which the large town of Kengtung is situated, the only large open valley met with; this valley contains several hundreds of villages and the hills surrounding it are bare and open, having been denuded of forest by the inhabitants. The country surveyed lay entirely within the State of Kengtung, the largest of the Southern Shan States, and included the main watershed of the Salween and Me-hkong rivers, which rises here to a height of 7,600 feet above sea level, the general elevation of the larger valleys being about 1,400 feet; to the east of the Salween the entire country is mountainous and exceedingly intricate; the rolling downs so characteristic of the western states are not met with here and one steep mountain range succeeds another, divided by narrow valleys. The general direction of the valleys is north and south, some of the rivers flowing to the north and some to the south with their basins dovetailed together in a most intricate manner. The lower slopes of the valleys are of confused contour and are thickly wooded, as are the summits and western slopes of the main range. Communications are good, the country being well provided with roads, mule-tracks, and foot-paths, and fairly well populated. Two tribes, the Kaws and Muhsös, unlike the Shans, were of great assistance to the survey and willingly furnished labour for transport and clearing purposes, and next season it is intended to engage two men of these tribes for each surveyor's squad and thus reduce the number of *khalâsis* imported from India.

91. The health of the party was generally good with the one exception mentioned above, though Babu Roy and most of the surveyors suffered from malaria at times. Morning mists interfered much with the work, during December and January. These mists hang over all the rivers till 10 or 11 o'clock every day, they do not rise above an elevation of about 3,500 feet, but unless the surveyor has work to take him above that level he has to sit idle for 2 or 3 hours every morning.

92. The cost-rates are much the same as those of former seasons; that of the triangulation is somewhat higher owing to Mr. Morton's illness and to the fact that the expenditure includes the cost of a small escort given to the triangulators who were working along the Siam frontier. The rates do not include expenditure in connection with the instruction of surveyors.

93. The computations of the triangulation and the fair mapping of the whole area surveyed were completed, and the maps together with 2 triangulation

charts were forwarded to head-quarters for publication. The Deputy Surveyor General inspected the party during the recess.

94. Next season the detail survey will be done on the scale of 1½ inch=1 mile, as an experiment, to ascertain whether the slight increase in scale will enable a vertical interval of 50 feet to be employed for the contouring of the hills, without unduly enhancing the cost of the work. The sheets to be surveyed are 93 $\frac{O}{12, 15, 16}$ and 93 $\frac{P}{9, 10, 13}$, 1,664 square miles, and sheets 93 $\frac{P}{11, 15}$ 102 $\frac{C}{4, 8, 13}$, 102 $\frac{D}{1, 2, 3, 5, 6, 9}$ will be triangulated up to the boundary line, the area being 1,781 square miles.

NORTH-WEST FRONTIER PROVINCE.

No. 12 PARTY.

95. The administrative control of the party was transferred from the Superintendent, Trigonometrical Surveys, to the Surveyor General of India, on 1st October 1905, and again to the Superintendent, Northern Circle (Frontier Surveys), on 6th August 1906.

Personnel.

Captain E. T. Rich, R.E., Offg. Deputy Superintendent, 2nd grade, in charge from 9th October 1905.
Lieutenant M. N. MacLeod, R.E., Assistant Superintendent, 2nd grade, from 19th April 1906.
Mr. R. F. Warwick, Extra Assistant Superintendent, 3rd grade, in charge till 8th October 1905.
Munshi Rahmatullah, Extra Assistant Superintendent, 5th grade.
Babu Dhani Ram, Extra Assistant Superintendent, 6th grade.
Mr. H. C. W. Stotesbury, Sub-Assistant Superintendent, 1st grade, from 14th October 1905.
13 Surveyors, etc.

Captain E. T. Rich, R.E., remained in charge of the party throughout the year, with the exception of a few days in October 1905, during which Mr. C. F. Erskine held temporary charge.

96. The field season extended from 22nd October 1905 to 13th June 1906, during this time the following programme of work was completed:—

(*a*) A network of triangulation covering 700 square miles.
(*b*) Rigorous detail survey on the scale of 2 inches=1 mile of 470 square miles of the area triangulated.
(*c*) Reconnaissance survey on the scale of 2 inches=1 mile of 143 square miles.
(*d*) Reconnaissance survey of 140 square miles on the 1 inch=1 mile scale.

97. The country surveyed was of a very varied nature and included portions of the flat and highly cultivated plains of Peshâwar, and its adjoining rugged hills; these hills, rising to nearly 7,000 feet in height, are similar to those generally met with on the North-West Frontier and consist of bold rocky spurs sparsely covered with scrub jungle and broken up by innumerable stoney nalas and dry ravines, knife-edged ridges rising to sharp peaks are common, and on these in February, the snow line is as low as the 5,000 feet level; the annual rain-fall in the hills is small and the water-supply, obtained chiefly from wells, only suffices for the maintenance of a scanty population and a very limited area of cultivation.

98. The cost-rates of the season's work are as follows:—

	Cost per square mile. *R a. p.*
Triangulation	14 11 0
2″ Rigorous survey	105 15 0
2″ Reconnaissance	24 8 0
1″ Reconnaissance	10 0 0
Fair mapping	31 11 0

99. The high rate for rigorous survey is due chiefly to the strength and number of guards attached to the surveyors, and also to the large number of Imperial and Provincial officers in the party in proportion to the strength of surveyors; to the latter cause is also attributable the high rate for fair mapping.

100. During the recess the fair drawing on the 1½-inch scale of the current season's survey has been almost completed, the computation of the triangulation has been finished, and a triangulation chart has been drawn. During the field

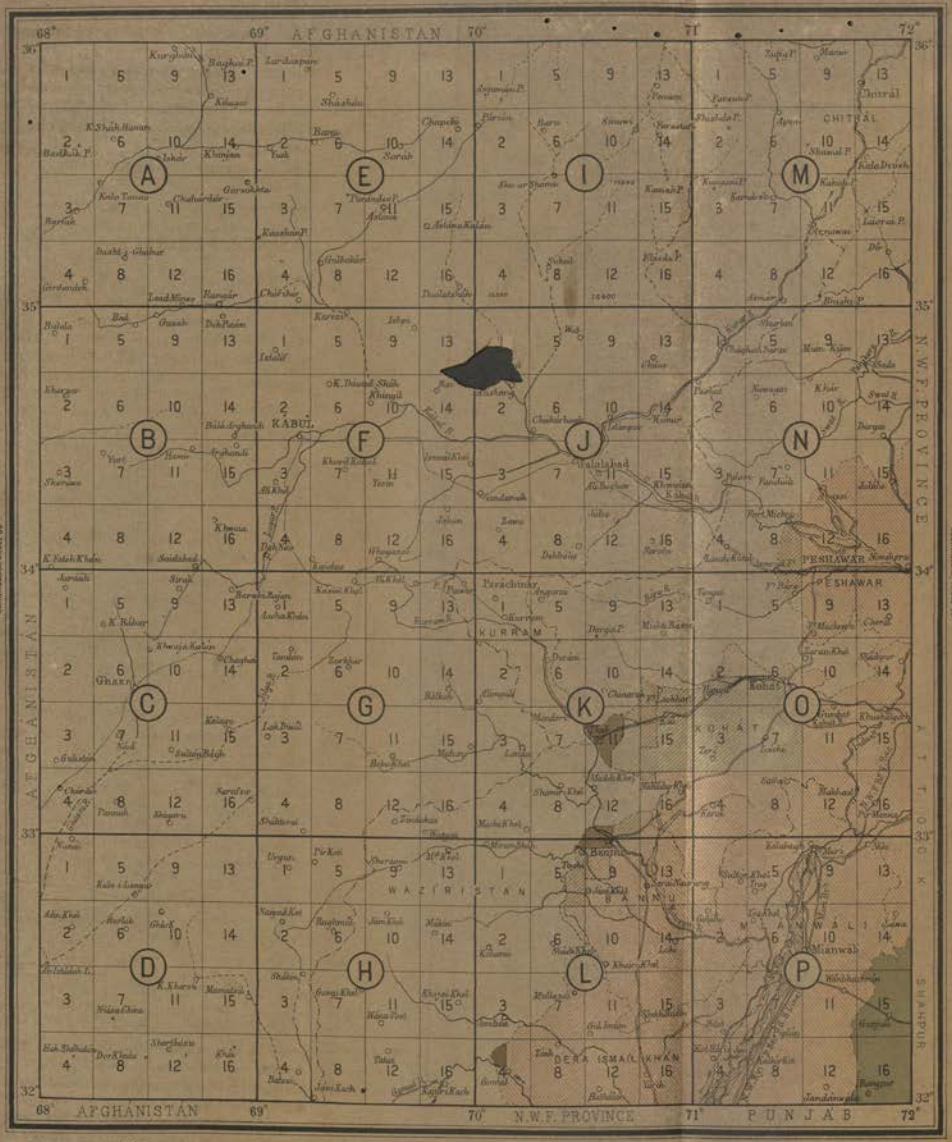
SHEET No. 88.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.

Continuation Sheet 37



NOTE.

1. The number in the heading is that of the Sheet of the India and Adjacent Countries Series of the Scale of 1 Inch.
2. The letters denote the Degree Sheets on the Scale of 1 Inch = 4 Miles contained within the above, while the small figures denote the numbers of the 1 Inch Sheets contained in each Degree Sheet.
3. When ordering a sheet on the Quarter Scale, only the number given in the heading should be used, e.g. No. 92 in the case of a Degree Sheet, the number in the heading and the Degree Sheet letter must be given, e.g. 92A. For a 1 Inch Sheet the number in the heading and the Degree Sheet letter and the 1 Inch Sheet number must be quoted, e.g. 92B.

Published under the direction of Colonel F. B. Lange, R. E., Surveyor General of India.

1907.

Scale 1 Inch = 28 Miles

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REFERENCES.

1. Degree Sheets published on the 1 Inch Scale
2. Sheets published in new style on the 1 Inch Scale
3. Sheets of the Quarter Scale
4. Treaty of Sheets in advance
5. Sheets of all other Sheets
6. Sheets of Sheets not published
7. Sheets under Sheet approximately contained in limits shown on Index.

Reg. No. 327-S. 07.

Helio. S. I. O., Calcutta.

season the draftsman of the party completed all the fair mapping of the work of previous seasons in Sind.

101. The programme of survey for the season 1906-07 consists of an extension of the triangulation and 2-inch survey.

102. The party was inspected by the Surveyor General and by the Superintendent, Frontier Surveys, at Mussooree during the recess.

NORTH-WEST FRONTIER PROVINCE.

No. 14 Party.

103. The party remained under the administrative control of the Surveyor General until 6th August 1906 when it passed into that of the Superintendent, Northern Circle (Frontier Surveys).

Personnel.

Captain H. L. Crosthwait, R.E., Officiating Deputy Superintendent, 1st grade, in charge from 1st October 1905 to 9th September 1906.
Lieutenant E. C. Baker, R.E., Assistant Superintendent, 2nd grade, in charge from 10th to 30th September 1906.
Mr. G. P. Tate, Extra Assistant Superintendent, 3rd grade.
Mr. C. George, Extra Assistant Superintendent, 3rd grade, from 1st to 31st October 1905.
Mr. J. O. Greiff, Extra Assistant Superintendent, 5th grade.
Mr. H. H. B. Hanby, Extra Assistant Superintendent, 5th grade, from 3rd October 1905.
Mr. J. H. S. Wilson, Extra Assistant Superintendent, 6th grade.
Mr. E. S. Biggie, Extra Assistant Superintendent, 6th grade.
Mr. H. B. Simsons, Sub-Assistant Superintendent, 1st grade.
Mr. A. B. Hunter, Sub-Assistant Superintendent, 2nd grade.
Surveyors, etc., 22.

104. Captain H. L. Crosthwait, R.E., held executive charge of the party throughout the year, with the exception of September 1906, when he proceeded on leave, and Lieutenant E. C. Baker, R.E., held charge.

105. The field season commenced on 25th September 1905 and closed on 20th May 1906, during this period the following programme of work was completed:—

(*a*) Triangulation and computation of 1,210 square miles for the current season's survey.
(*b*) Triangulation of about 1,000 square miles in Kohat district for next year's surveys.
(*c*) Detail survey on the scale of 2 inches = 1 mile of 737 square miles.

106. The country surveyed was very hilly and broken, and varied in altitude from 3,500 to 13,000 feet, at the higher levels work was much interfered with by the weather.

107. The cost rate for triangulation was—

	Per square mile.
(*a*) triangulation and computation for current work . .	25 0 0
(*b*) triangulation for next year's work . . .	10 8 0

108. The detail survey has cost about R110 per square mile, this large rate is due to the heavy charges for militia, local guards, transport, local and other allowances to surveyors, etc., amounting to R54 out of the total of R110 per square mile of survey.

109. During the recess the fair drawing of the 8 standard sheets showing all the area surveyed has been practically finished, 6 of these will be submitted to press in the course of the next few months, but the other two cannot be published until next season's surveys have been added to them. All the computations have been completed. A small detachment of draftsmen was employed at Dehra Dun throughout the field season in completing the mapping of the Cawnpore sheets, which had fallen into arrears on account of the special work which the party was called on to perform in connection with the Delhi manœuvre map.

110. The programme for next season's survey is an extension of the recent work of this party eastwards in the Kohat district, and it will extend on the north as far as the administrative border of Kohat and will be bounded on the south by the 33rd parallel, it will therefore include the larger part of Kohat district.

111. The party was inspected by the Surveyor General at Mussooree in August.

NORTH-WEST FRONTIER PROVINCE.

No. 15 Party.

112. The programme of the party for the season consisted in the execution of topographical surveys on the scale of 2 inches to the mile for publication on the scale of 1 inch = 1 mile.

Personnel.

Major C. L. Robertson, C.M.G., R.E., Deputy Superintendent, 1st grade, in charge.
Lieutenant H. S. May, R.E., Assistant Superintendent, 1st grade.
„ O. H. B. Trenchard, R.E., Assistant Superintendent, 2nd grade, from 16th January 1906.
Mr. J. A. Freeman, Extra Assistant Superintendent, 5th grade.
Mr. D. Hunter, Extra Assistant Superintendent, 6th grade.
Mr. H. C. H. Cooper, Extra Assistant Superintendent, 6th grade.
Subadar Kanak Singh, Sub-Assistant Superintendent, 2nd grade.
Mr. E. B. West, Sub-Assistant Superintendent, 2nd grade.
Mr. P. D. Simpson, Sub-Assistant Superintendent, 2nd grade.
Mr. E. C. O'Sullivan, Sub-Assistant Superintendent, 2nd grade.
Mr. T. P. Dewar, Sub-Assistant Superintendent, 2nd grade.
Mr. D. K. Rennick, Sub-Assistant Superintendent, 2nd grade.
Mr. A. G. Harrington, Sub-Assistant Superintendent, 3rd grade.
Mr. E. A. Wainwright, retired Provincial Officer.
Mr. J. McHatton, retired Provincial Officer.
Surveyors, etc., 79.

113. Surveys of the Murree, Nowshera, Campbellpore, Bannu, Kohat, Abbottabad, Delhi, Muttra, Roorkee, Dalhousie, and Bukloh cantonments were carried out by a detachment of the party working under Mr. J. McHatton up to the end of December 1905. From 1st January 1906 this work and the men who were employed on it were transferred from the party and the report on these operations will be found under the heading cantonment surveys.

114. Surveyor Lal Singh, R.S., accompanied Colonel Bruce on his journey through Eastern Turkestan and China.

115. The members of the party employed in the North-West Frontier Province assembled at Dera Ismail Khan about the end of September 1905, and after some delay reached their ground by the end of October. The party continued in the field till 12th July 1906.

116. The health of the party was good until towards the close of the field season, when the strain of carrying on work in the field during the hot weather months told severely on the health of all, and fever was very prevalent.

117. On the party's taking the field, the supervision of the arrears of mapping was entrusted to Mr. E. A. Wainwright, who, on retiring from the service at the end of 1903, had been re-employed in connection with this work, and the officer in charge of the party was thus relieved of the immediate control of this work during the field season. The draftsmen of the party were also placed under Mr. Wainright as a detachment of the party, and much of the arrears of mapping was worked off by the end of September.

118. The late return of the party to recess quarters, the difficulty of obtaining a speedy supply of reductions of the field sections during the rains, and changes in the style of mapping all contributed to delay the preparation of the fair sheets, and the mapping is consequently still in arrears.

119. The outturn of survey and mapping, and the cost-rates are given below:—

	Area in square miles.	Cost rate per square miles.
		R a. p.
Triangulation secondary series	800	at 29 15 6
Triangulation for 2-inch survey	1,350	„ 38 9 9
Detail survey on 2-inch scale	1,741·34	„ 85 13 6
Mapping 2-inch surveys	2,495·57	„ 4 13 2

120. The fair mapping of the arrears completed was carried out in accordance with the orders obtaining at the time of its commencement, for publication to the scale of survey in 2 colours only.

121. The programme for the field season 1906-07 has been twice changed since the 1st August 1906. The final programme contemplates the execution of some 800 square miles of topographical survey on the scale of 2 inches = 1 mile, and as much triangulation in advance as time will permit. There is no triangulation suitable for 2″ topography ready in this area, and the triangulators will not be able to reach their ground and commence work before the middle of November 1906 and the commencement of topographical operations must therefore be postponed till the latter part of the following month.

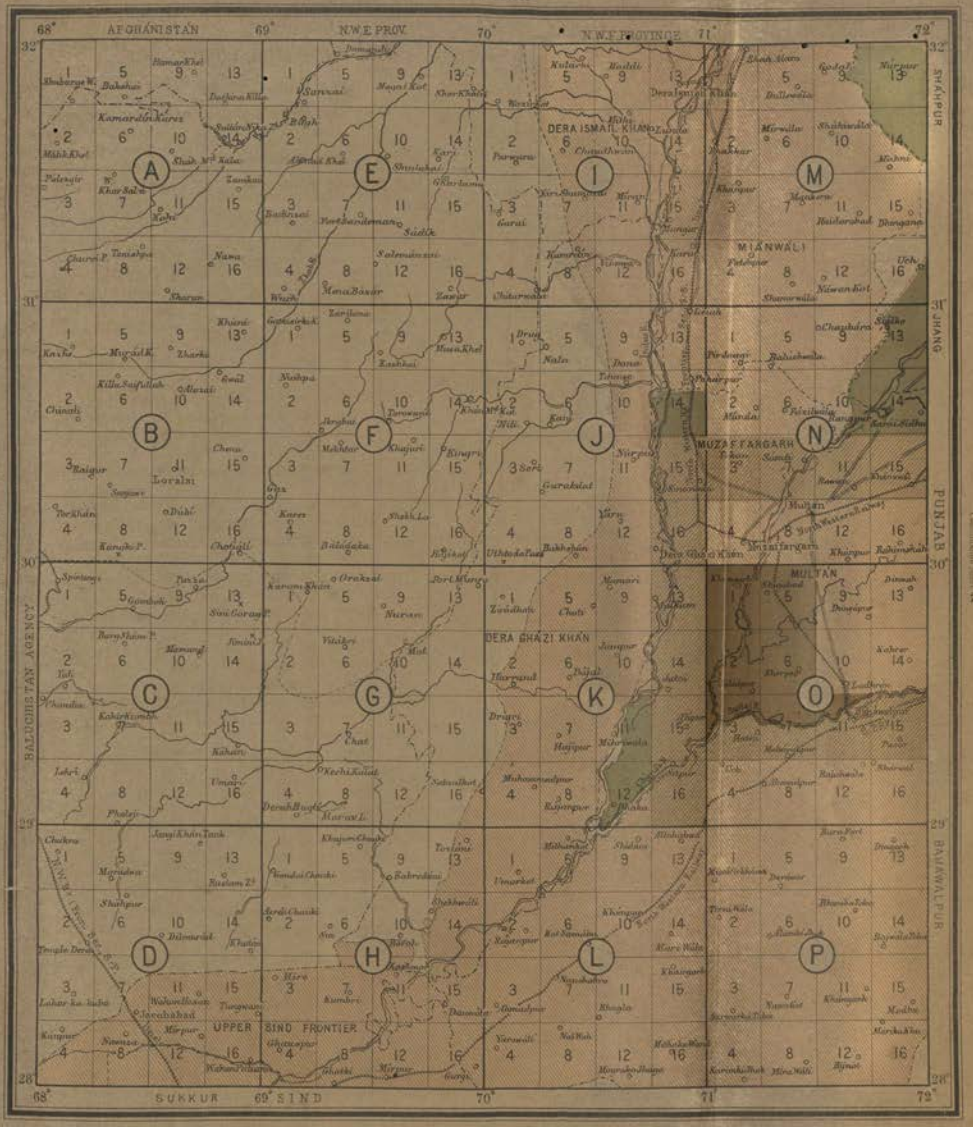
SHEET No. 89.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.

Construction Sheet 58



NOTE.

1. The number in the margin is that of the Sheet of the India and Adjacent Countries Series on the Scale of 1 inch to 4 miles.
2. The letters outside the Degree Sheets on the Scale of 1 inch = 4 miles correspond with the 1 Inch Sheets on the Scale of 1 inch = 4 miles.
3. When referring to sheet on the 1 Inch Scale, note the number shown in the margin above the letter, e.g. No. 53 in the case of a 1 Inch Sheet, the number is the reading and the Degree Sheet letter, must be given, e.g. 53 A. For a 1 Inch Sheet the number is the reading the Degree Sheet letter and the 1 Inch Sheet number must be quoted, e.g. 53 A 1.

Published under the direction of Colonel F. B. Longe, R.E., Surveyor General of India.

Scale 1 Inch = 20 Miles

Miles 10 0 10 20 30 40 50 Miles

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REFERENCES.

1. Degree Sheets [illegible] on the 1 Inch Scale.
2. Sheets [illegible] on the 1 Inch Scale.
3. [illegible]
4. [illegible]
5. Boundaries.
6. Provisional [illegible]
7. [illegible]

Reg. No. 326-S. 07.

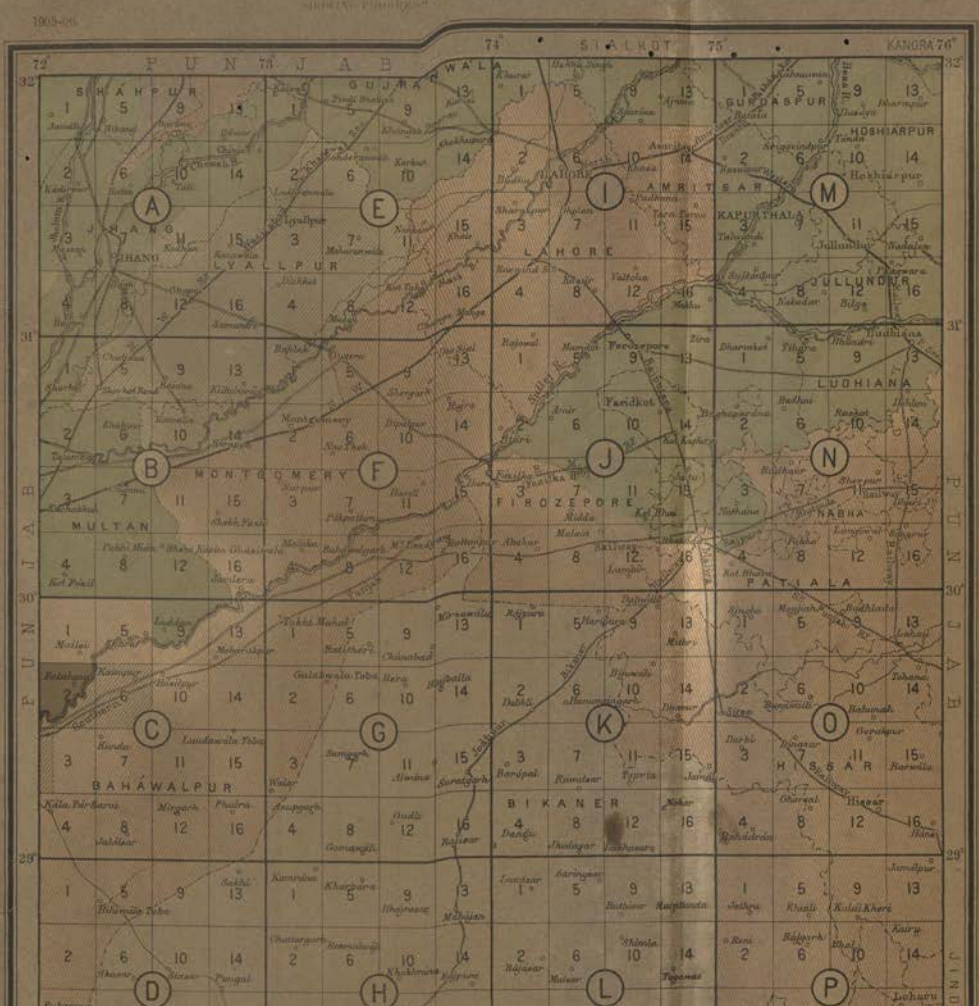
Survey of India Offices

SHEET No. 44.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

OF THE MODERN TOPOGRAPHICAL SURVEYS.

1905-06.



NOTE

1. The number in the heading is that of the Sheet of the India and Adjacent Countries Series of the Scale of 1 Inch.
2. The letters beside the Upper Sheets on the Scale of 1 Inch = 4 Miles contained within the above, while the small figures beside the numbers of the 1 Inch Sheets contained in each Upper Sheet.
3. When ordering a sheet on the 1 Inch Scale with the number given in the heading should be used e.g. 5 in the case of a Upper Sheet, the number in the heading and the Upper Sheet letter must be given e.g. 5 for a 1 Inch Sheet the number in the heading the Upper Sheet letter and the 1 Inch Sheet number must be given e.g. 5 [illegible]

Published under the direction of Colonel F. B. Longe, R.E., Surveyor General of India.

1907.

Scale 1 Inch = 28 Miles

Miles 0 10 20 30 40 50 60 70 80 90 100 Miles

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REFERENCES

1. [illegible] on the 1 Inch Scale.
2. [illegible] on the 1 Inch Scale.
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]

Reg. No. 324-S. 07.

122. The personnel of the party has undergone great changes in all grades during the season. One Imperial branch officer, all the senior Provincial officers, and more than one-third of the native surveyors have been transferred from it to other parties. The result, so far as size is concerned, is a unit more suited than formerly to the work in hand, but the lack of experienced Provincial assistants is found a disadvantage. These transfers were necessitated by the concentration of a large number of parties on or near the frontier, the members of which were in many cases unsuited for the work that they would have been called upon to perform.

123. The party was inspected by the Surveyor General in August 1906 in Mussooree.

PUNJAB.

NO. 18 PARTY.

124. The party remained under the administrative control of the Surveyor General until August 28th when it passed into that of the Superintendent, Northern Circle (Frontier Surveys).

Personnel.

Captain M. O'C. Tandy, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Lieutenant F. F. Hunter, I.A., Assistant Superintendent, 2nd grade, till 26th April 1906.
Mr. W. Robert, Extra Deputy Superintendent, 1st grade, till 26th February 1906, and subsequently specially re-employed.
Mr. G. A. Knight, Extra Assistant Superintendent, 1st grade.
Mr. J. Marten, Extra Assistant Superintendent, 2nd grade, from 16th June 1906.
Mr. G. J. S. Rae, Extra Assistant Superintendent, 5th grade.
Mr. C. E. C. French, Extra Assistant Superintendent, 6th grade.
Mr. J. R. Newland, Sub-Assistant Superintendent, 1st grade
Babu Maya Das Puri, Sub-Assistant Superintendent, 1st grade.
Mr. L. Williams, Sub-Assistant Superintendent, 2nd grade, till 15th November 1905.
Mr. F. C. Pilcher, Sub-Assistant Superintendent, 2nd grade, till 15th November 1905.
Mr. A. G. Harrington, Sub-Assistant Superintendent, 2nd grade, till 15th November 1905.
Mr. F. H. Grant, Sub-Assistant Superintendent, 2nd grade, till 15th November 1905.
Mr. C. E. Tapsell, specially re-employed till 28th February 1906.
Surveyors, etc, 95.

125. The recess office closed in Simla on 1st November 1905, and opened again on 12th June 1906.

126. Although the field season was extended to rather over 7 months it was found impossible to complete the full programme of supplementary survey and two standard sheets (about 525 square miles) had to be omitted, with this exception no change was made from the sanctioned programme.

The year's work was of a very varied character and extended into 16 districts of the Punjab and North-West Frontier Province and Jammu and Bahâwalpur States, it will be described under 9 headings.

127. *Supplementary Topographical Survey on the 2-inch scale.*—The necessity for completing to margin 6 standard sheets which had been partly surveyed in previous years and the consequent scattering of the surveyors over a large area in Multân, Muzaffargarh, Dera Ghâzi Khan districts and Bahâwalpur State made the supervision of this work rather difficult for the small staff available.

The nature of the work was similar to that of previous years, the only difference being that the compilations from the settlement maps were checked in the field much more thoroughly than they had been in the past, this decreased the rate of outturn and is responsible for the increased cost of ₹15·8 per square mile as compared with ₹11·2 for last year, the total outturn of this class of work for the year was 2,343 square miles. As in previous years wherever riverain plane tabling on the 4-inch scale had been recently carried out the area thus surveyed has not been revised but will be used in the preparation of the fair maps.

The total area of supplementary, revision, or re-survey carried out during the year was 3,047 square miles giving an average cost-rate of ₹13·3, adding to this the cost of compilation, traversing and fair drawing, the cost of the current year's finished maps will be ₹23·3 per square mile as compared with ₹20·1, ₹19·7 and ₹21·6 the figures for the past three years. Considering the more detailed check to which the compilation has been subjected and the extra detail shown on the fair maps this increase is not extravagant.

At the commencement of the field season only 16 surveyors were available for field work as a section including 4 surveyors was detained in Simla in order to complete the fair drawing of certain maps, to this must be largely attributed the abandonment of two standard sheets from the programme.

128. *Revision Survey.*—Three hundred and thirty square miles of the Muzaffargarh "Thal" were revised on blue prints of the existing maps on the scale of 2 inches to 1 mile; this "Thal" consists of a sea of irregular sandhills of from 10 to 50 feet in height with few and very scattered habitations; the ground being too uneven to permit of accurate chaining, and the traversed trijunctions being very far apart, this survey was based on a compass traverse and the distances were measured with the subtense bar; one surveyor was employed on the work from January to June, his monthly outturn was 55·8 square miles and the cost R5·8 per square mile. Copies of the published 4-inch and 6-inch maps of Dera Gházi Khan and Bahawalpur towns were brought up to date during the year, as they fell within the area of survey, and the course pursued was thought preferable to making a new 2-inch survey or to accepting the old maps without revision.

129. *Resurvey.*—The 374 square miles of desert falling south of the Southern Punjab Railway in Bahawalpur State were resurveyed on the 1-inch= 1 mile scale, the country was somewhat similar to the Muzaffargarh "Thal" but the sandhills being smaller and less well defined it was decided to do the survey on the 1-inch scale and to enlarge it before fair drawing; the system of survey was identical with that employed in the 2-inch revision but the reduced scale and the easier nature of the ground allowed a monthly outturn of 99·1 square miles per man and a cost rate of R3·9 per square mile.

130. *District Traverse for Supplementary Surveys.*—This was carried out in Jhang, Lyallpur, Montgomery and Shahpur districts and in Bahawalpur State. In the two former districts main traverses had been run in 1904-05 and the season's work consisted in supplementing this with minor circuits picking up trijunctions and base lines; this traverse was also extended so as to include such portions of Montgomery district as had not been previously traversed; the traverse in Bahawalpur State was required for the current season's surveys. Although Shahpur district had been completely traversed in previous years, before the formation of the Jhelum Colony, the work was now of little value for topographical surveys and it was therefore decided to retraverse the area covered by the new colony. Main traverses were completed during the year throughout the colony and sub-circuits throughout a small portion of it. The area and the cost of these traverses for the year (inclusive of the work in Kohat) is approximately 4,600 square miles costing R5·8 per square mile against R4 for last year.

131. *Special Traverse and Survey in Kohat District.*—This consisted in fixing by traverse or triangulation all the boundary pillars on some 100 miles of the northern boundary of Kohat district; in surveying this boundary on blue prints of the existing 1-inch maps; and in the detailed traverse of about 180 square miles of the district; the work was carried out at the request of the Settlement Officer, Kohat.

132. *Riverain Traverse.*—During the year all the riverain traverses required by the Settlement Commissioner have been completed, the work though small in extent was extremely scattered and lay on the Indus river in Miánwáli, Dera Ismail Khan, Peshawar and Attock districts, on the Ravi river in Montgomery and Gurdaspur districts and Jammu State, on the Sutlej river in Multán, Ferozepur and Ambála districts and Bahawalpur State. 729 linear miles of traverse were run at a cost of R9·3 per square mile as against R9·5 for last year.

133. *Map Compilation and Reduction of village maps.*—For current supplementary surveys a section was employed on this work in Bahawalpur State and Multán during the first few months of the field season; compilation for next year's survey has not been undertaken during the recess on account of the uncertainty as to where the party will be working.

The cost of compilation has been R1·2 per square mile. The reduction and compilation of village maps has continued throughout the year for the riverain maps and during the year over 11,000 village *musavis* have been dealt with.

134. *Fair Drawing and Recess duties.*—One section remained at Simla until the end of February fair drawing certain maps, by this date it had practically finished the fair drawing, and what little work still remained has been completed during the recess and the last of these maps will be sent to press before the party takes the field. The cost of this survey inclusive of triangulation and fair drawing has amounted to R307·3 per square mile.

One section remained in Simla under Mr. Tapsell, who had been specially re-employed after his retirement in order to supervise the fair drawing of the

Punjab plains maps, until 28th February, when the period of this officer's re-employment expired and the section was transferred to Multán; during the year all arrears of this work have been completed.

A section under Mr. Robert, also a re-employed officer, remained at Simla throughout the year and was employed on the drawing of the Himalayan arrears and on the preparation of triangulation charts. There still remain 14 fair maps and 19 triangulation charts to be drawn, but 6 of the maps and 7 of the charts are now in hand and it is hoped that all these arrears may be worked off during next recess. The work done during the year has included drawing on the 4-inch and 2-inch scales for reproduction, and on the 2-inch and 1½-inch scales for reduction to 1-inch, and it is therefore not possible to give an accurate cost-rate per square mile.

On the riverain fair drawing a section has been employed throughout the year at Multán and Simla; as the officer in charge of this section had at the same time to superintend field work, the examination of fair sheets has fallen somewhat behind-hand, but some 50 fair sheets are now practically ready for press and another 150 are in various stages of preparation; the riverain field work being now completed the remainder of the fair drawing becomes an arrear, it is probable that a section of about 15 men will be required for this work for about two years. The approximate cost of reducing and compiling the village '*musavis*' and fair drawing the maps has been ₹3·34 per square mile, this rate is much the same as last year.

Two strong sections have been employed during recess on fair drawing the current year's surveys on the 1½-inch scale for reduction to 1-inch. Although the total area surveyed was only 3,047 square miles, the addition of riverain areas and the portions of 6 standard sheets partially surveyed in 1903—05 has raised the total area of fair mapping to 4,180 square miles or 16 standard sheets; every effort has been made to get this work completed, and although the shortness of the recess consequent to the prolongation of the field season has rendered this difficult, it is hoped that all will be finished before the end of the recess and that only a small amount of final examination will remain undone.

135. *Special maps, etc.*—Lieutenant F. F. Hunter, I.A., was attached to the party till April and employed on the compilation of a special map for the Foreign Department and one draftsman was placed at his disposal for this purpose.

The fair drawing of 5 special maps on various scales has been completed for the Foreign Department during the year.

During the recess proposals have been made with a view to modifying and improving the present system of settlement surveying in the Punjab, an experiment on the basis proposed is now being carried out in Gujranwala district and as the system has been favourably reported on, it has been decided to employ it in the re-survey of Gujránwála and Siálkot districts which is to be carried out during the coming winter; it is hoped that 4 settlement kanungos will be sent to the party for the last few weeks of the recess to carry out the plotting of the traversed points on the 3,000—4,000 *musavis* which will be required for this survey.

136. *Programme for next year.*—This allows for:—

Triangulation for the current and for next year's surveys in parts of Bannu, Dera Ismail Khan and Miánwali districts. Such traverse work as may be required for the surveys in Dera Ismail Khan and Bannu; the completion of the traverse of the Jhelum colony in the Shahpur district commenced during this year, and perhaps a traverse of the proposed new colony in the lower Bari Doab.

Two-inch supplementary survey or re-survey in Bannu, Dera Ismail Khan and Kohat districts.

137. The party was inspected during the recess by the Surveyor General on the 8th October and by the Superintendent, Northern Circle (Frontier Surveys), on the 22nd and 26th August.

NORTH-WEST FRONTIER.

QUETTA PARTY.

Personnel.

Captain G. A. Beazeley, R.E., Officiating Deputy Superintendent, 1st grade, in charge, from 5th August.
Mr. H. C. H. Cooper, Extra Assistant Superintendent, 6th grade, from 20th August.
And the following Probationary Sub-Assistant Superintendents, 3rd grade :—
Mr. L. Williams from 21st August.
Mr. J. McCraken from 5th September.
Mr. F. C. Pilcher „ 21st August.
Babu A. K. Mitra „ „ „
Mr. A. A. Graham „ „ „
Mr. R. C. Hanson „ „ „
Mr. A. J. A. Drake „ „ „
Mr. F. H. Grant „ „ „
Two soldier surveyors under instruction.

138. This party was formed at the end of August.

139. It was formed primarily as an instructional one to give the above young provincial officers a training in frontier work before drafting them into the frontier parties.

140. As the party had, by the end of September, only completed a very small area, the result of the season's work will come into next year's report.

FOREST SURVEYS.

NO. 9 PARTY (INDIA).

141. The Party was employed on 4-inch forest surveys in most of the provinces of the Bengal presidency and on 2-inch topographical surveys in Assam. There was no month in the year in which some of the party were not in the field.

Personnel.

Major P. J. Gordon, I.A., Superintendent, Forest Surveys, in charge.
Mr. C. George, Extra Assistant Superintendent, 3rd grade.
Mr. C. Litchfield, Extra Assistant Superintendent, 5th grade.
Mr. P. A. T. Kenny, Sub-Assistant Superintendent, 1st grade.
59 Surveyors.

142. Two camps under Messrs. George and Kenny continued forest surveys on the 4-inch scale in the Katha and Shwebo districts of Upper Burma and one under Mr. Litchfield completed the 4-inch forest surveys in Nowgong and also surveyed an area of 571 square miles in the Durrang district of Eastern Bengal and Assam. Small sections under native surveyors were employed on 4-inch detail surveys in Hazára, Ráwalpindi, Lahore, Tehri Garhwál, Pilibhit and the Garo hills. Work in Pilibhit had to be stopped owing to a severe outbreak of cholera, from which 1 surveyor and 2 khalasis died, and in the Garo hills the season's work narrowly escaped being lost through a wild elephant having, in the course of an attack on the surveyor, stepped on his plane table.

143. A small area was triangulated in Tehri Garhwál and in Chittagong the Sitapahár reserve was traversed, the result of this traverse showed the area of the reserve to be over 27 square miles instead of 11 as estimated when the reserve was notified.

144. The area topographically surveyed on the 2-inch scale was that included in standard sheets 83 $\frac{B}{9, 13}$ as well as the portions of reserved forest situated to the east, west and north of these sheets. Considerable difficulty was found in surveying the Bhutan boundary as many of the pillars had disappeared and it is probable that the maps will have to be published provisionally without any demarcated boundary being shown thereon. The surveyors were new to this class of work and the average outturn was only 52 square miles *per* surveyor for a season of six months. Much of the country consisted of uncultivated tracts covered with high grass and consequently difficult to survey. Short lines of levels had to be run in order to obtain additional heights in this flat country.

145. A survey on the 4-inch scale was made of the boundaries of the *rakhs* of the Salt range in the Shahpur district of Punjab.

Reg. No. 458-S. 07.

146. The outturn for the year under report and the two preceding years are given in the following table:—

Description of Survey.	Outturn in square miles.			Cost-rate *per* square mile.		
	1903-1904.	1904-1905.	1905-1906.	1903-1904.	1904-1905.	1905-1906.
Detail Survey 4 inches = 1 mile.						
North-West Frontier Province Punjab	209	262	78	25·0	24·6	52·8
Central Provinces	2·5	...	0·5	57·6	...	...
United Provinces of Agra and Oudh.	36	...	98	27·1	...	32·0
Bengal	310	232	...	64·0	76·7	...
Eastern Bengal and Assam	160	148	19	85·2	85·5	129·8
Burma	447	501	570	90·7	91·4	100·3
TOTAL	1164·5	1143	765·5	...	...	...
Detail Survey 2 inches = 1 mile.						
Eastern Bengal and Assam	...	...	571·3	...	...	30·5
4-inch Boundary Survey.						
Punjab	...	...	839(*a*)	...	...	4·3(*b*)
Burma	...	..	* 40(*a*)	...	...	...
TOTAL	...	...	879(*a*)	...	...	...
Traversing	1552(*a*)	1444(*a*)	541(*a*)	23·9(*b*)	19·2(*b*)	21·4(*b*)
Levelling		..	130(*a*)	...	...	6·1(*b*)
Triangulation	2483	2242	447	7·7	6·2	3·5

* On 2-inch scale. (*a*) Linear miles. (*b*) *Per* linear mile.

The outturn cannot be well compared with that of previous years as much of the work was of a different nature. The sanctioned programme was completed with the exception of about 40 square miles in Pilibhit where the survey had to be abandoned on account of a severe epidemic of cholera, and of some 30 square miles in Chittagong which could not be arranged for owing to the area of the reserve proving, after traverse, to be nearly three times the notified area.

The cost-rates owing to the work being performed under different conditions from those of last year require some explanation. In spite of the increase in the rates the work was done as economically as formerly. In the Punjab and Frontier Province the forest areas were widely scattered and some of the expenditure for work shown in last year's returns had to be included in calculating the cost-rates. In the United Provinces the high rate was due to the work being interrupted by cholera. In Eastern Bengal and Assam the forest areas surveyed presented considerable difficulties and were much scattered. In Burma no traversing or triangulation was done, and the plane-tabling had to bear the whole of the supervision charges instead of only a portion of them as formerly.

The cost of the 2-inch surveys in Assam may be considered moderate, considering the physical difficulties of the country and the fact that all the surveyors were new to this class of work.

A comparison of the cost of one year's work with another is always difficult and unsatisfactory as conditions are never exactly the same for any two years.

147. During the year good progress was made in the drawing of forest maps of which 196 including second editions was sent to press and 220 published.

148. It is proposed next season to break up No. 9 party as a forest survey party and to reconstruct it as a topographical party. Most of the surveyors will be transferred to Frontier Survey parties.

149. The total expenditure for the year amounted to R1,20,283, of which R72,354 are chargeable to the Forest department.

BOMBAY FORESTS.

No. 17 Party.

150. The party left Poona for the field at the end of November, and returned to its recess quarters early in June, giving a full working season of six months.

Personnel.

Mr. B. G. Gilbert Cooper, Superintendent, 2nd grade, in charge.
Mr. S. F. Norman, Extra Assistant Superintendent, 1st grade.
Babu Amar Singh, Extra Assistant Superintendent, 5th grade.
Mr. P. R. Anderson, Extra Assistant Superintendent, 6th grade.
41 Surveyors, etc.

The party was divided into three camps under Mr. S. F. Norman, Babu Amar Singh, and Mr. P. R. Anderson respectively, and continued the survey on various scales of forest areas in the Northern and Central Circles of the Bombay presidency; these operations comprised:—

(1) *Northern Circle.*—Completion of the detail survey on the 8-inch scale of teak reserves in the Thána district.

(2) *Central Circle.*—Continuation of the supplementary triangulation and detail survey on the 4-inch scale in the Khándesh district. Completion of detail survey on the 4-inch scale in the Sátára district.

151. There was a considerable amount of sickness in the party, especially in Thána and West Khándesh. In Sátára the health of the men was somewhat better. One surveyor was pensioned and two died from plague during the year, adding to the already long death roll from this cause in the party.

152. The following table shows in detail the outturn and cost-rates for the year under report and the two previous years:—

Description of Survey.	Outturn in sq. miles.			Cost-rates *per* sq. mile.		
	1903-04.	1904-05.	1905-06.	1903-04.	1904-05.	1905-06.
				R	*R*	*R*
Triangulation . . .	677	1,010	680	15·3	12·2	13·2
Topography 4-inch scale .	576·19	597·48	630·85	67·5	62·3	87·4
Topography 8-inch scale .	157·75	187·47	126·00	138·8	144·8	173·2

The cost-rates show a considerable increase over those of last season. This is due to a great extent to the inclusion for the first time of the charges for the publication of maps in the accounts. There were also local considerations which affected the rates and the outturn in an adverse manner, such as the necessity for the employment of coolie carriage in Sátára and Thána, and the difficult country met with in these districts.

153. The total expenditure for the year amounted to R82,630, of which R60,156 are chargeable to the Forest department, the balance R22,474 being an Imperial charge against the Survey of India.

154. One hundred and thirty-eight sheets have been sent to press and 72 have been published during the year.

At the end of the current recess 143 sheets will still remain unmapped, but it is hoped that, with the aid of a drawing section during the field season, most of the forest maps will be sent to press by the end of next year.

155. Large scale surveys of forests in Bombay have now been practically completed with the exception of those in Bijapur, where the value of the reserves was not deemed sufficient to justify the expenditure, and of the remaining forests in Khándesh, an area of nearly 1,500 square miles. It was originally intended to survey these forests on the 4-inch scale, but as, in the opinion of the conservator, maps on the 1-inch or 2-inch scales will suffice for Forest administrative purposes, the Government of Bombay has decided, with a few unimportant exceptions, to forego this part of the party's programme: it has therefore been decided to employ the party in future on topographical surveys. The programme for next season will consist of triangulation in degree sheet Nos. 46-K and 46-O and revision of 2-inch surveys and re-survey on the 2-inch scale of the area formerly surveyed on the 2-inch scale in sheet No. 46-K, also the 4-inch survey of forest boundaries in the same sheet, and the survey of about 60 square miles of forest for the sake of completing in a uniform scale the 4-inch survey of certain talukas.

156. The party was inspected in September by the Superintendent of Forest Surveys.

MADRAS FORESTS.

No. 19 Party.

157. The party, divided into 4 camps under Provincial officers, was distributed as follows:—

Personnel.

Mr. G. T. Hall, Extra Deputy Superintendent, in charge.
Mr. J. Smith, Extra Assistant Superintendent, 4th grade.
Mr. W. F. E. Adams, Extra Assistant Superintendent, 5th grade.
Mr. M. J. Sheehan, Extra Assistant Superintendent, 5th grade.
Mr. B. C. Newland, Sub-Assistant Superintendent, 3rd grade.
Babu Balaji Dhondiba, Sub-Assistant Superintendent, 3rd grade (Probationary).
57 Surveyors, etc.

No. 1 camp under Mr. J. Smith with 12 surveyors and 5 apprentices employed on 4-inch surveys of forests in the Godavari district.

No. 2 camp under Mr. W. F. E. Adams with 11 surveyors and 3 apprentices employed on 4-inch surveys of forests in North Malabar and South Canara districts.

No. 3 camp under Mr. M. J. Sheehan with 12 surveyors and 5 apprentices employed on 4-inch surveys of forests in the Ganjam district.

No. 4 camp under Babu Balaji Dhondiba with 3 surveyors employed on 4-inch forest surveys in the Chingleput and Ganjam districts.

Mr. B. C. Newland and one surveyor were also employed on triangulation in North Malabar in preparation for the proposed 2-inch topographical survey in that district.

Two traversers were employed in traversing the recently demarcated Mysore-South Canara Boundary, and one for a short period in traversing the boundaries of Forest reserves in North Malabar.

158. The party left its recess quarters in Bangalore early in November 1905 and, with the exception of the detachment working in South Canara which was detained till the end of June, closed work at the end of May.

159. The following table shows in detail the outturn and cost-rates for the year under report and the two preceding years:—

	Area surveyed.			Cost-rates *per* sq. mile.		
	1903-04.	1904-05.	1905-06.	1903-04.	1904-05.	1905-06.
				₹	₹	₹
Triangulation	1,937	1012	2,150 (*a*)	...	...	6 (*a*)
Ditto	...	...	70 (*b*)	9	14	33 (*b*)
Traversing (*c*)	247	29	174	19	31	28
Topography	803	750	832	102	124	104

(*a*) For 2-inch topography. (*b*) For 4-inch topography. (*c*) Linear miles.

The work was examined by 290 linear miles of test line and numerous *in situ* fixings.

The cost-rates generally show a satisfactory decrease over those of last season.

160. The country surveyed presented much the same difficulties as that surveyed in previous years. There was much sickness among the members of the party especially in Ganjam and North Malabar, and during the recess season much valuable time was lost from sickness contracted in the field.

161. The difficulty of securing a sufficiency of labour retarded the progress of the work in Ganjam, and assumed an acute phase in North Malabar, where labour is scarce and rates high; in spite of the assistance of the civil officer of the district, work was often at a standstill owing to want of men. The permanent employment and high wages offered by planters, and the contract system of the

Forest department, are more attractive to the inhabitants than employment with a survey party for a short period and often at a distance from their homes. It is probable that next season all the labour required for the Malabar survey will have to be imported. Many hours daily were often lost through coolies insisting on returning to their homes, sometimes miles away, and only returning next morning after the best hours for survey work had passed.

162. The average outturn *per* man *per* mensem ranged from 3·3 square miles in Malabar to 5·4 in Chingleput. The poor outturn in the former district was due in great measure to the labour difficulties referred to above.

163. With the exception of the Malabar sheets, which will be taken up next season, all maps will be completed before the end of the recess, but some of these will have to be withheld from press pending verification of boundaries and the survey of omissions. 81 maps were sent to press and 61 were published during the year.

164. The total expenditure of the party for the year was R1,06,926, of which R68,209 is debitable to the Forest department.

The Madras government having agreed to forego further large scale forest surveys, with the exception of those in Ganjam which it is proposed to complete, the party will in future be employed on regular topographical surveys.

The programme for 1906-1907 comprises—

(1) Triangulation in degree sheets 58A and 58B.
(2) 2-inch topographical survey of 2,000 square miles in North Malabar and Coorg falling in degree sheets 49M and 58A.
(3) 4-inch survey of about 340 square miles of forest in Ganjam and North Coimbatore.
(4) Traversing of 150 square miles of forest boundaries in Trichinopoly and of reserves falling in the area to be topographically surveyed in North Malabar.

165. The party was inspected during August by the Superintendent of Forest Surveys.

166. The season's work was verified with the aid of the government notifications by the district forest officers of Godavari, Ganjam, South Canara, North Malabar, and Chingleput.

BURMA (FORESTS).

NO. 20 PARTY.

Personnel.

Captain A. Mears, I.A., Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. P. F. Prunty, Extra Assistant Superintendent, 1st grade.
Mr. C. C. Byrne, Extra Assistant Superintendent, 6th grade.
Babu Pramada Ranjan Roy, Sub-Assistant Superintendent, 1st grade, from 11th June 1906.
Mr. S. S. Fielding, Sub-Assistant Superintendent, 1st grade, from 29th March to 13th May 1906.
Mr. J. H. Williams, Sub-Assistant Superintendent, 1st grade.
Munshi Amjad Ali, Sub-Assistant Superintendent, 2nd grade.
66 Surveyors, etc.

167. The party left recess quarters at Dehra Dún on the 6th November and the majority of the camps had commenced field work by the 1st of December. The field season was closed in Upper Burma on the 8th May and about a week later in Lower Burma.

168. The party was divided into 5 camps as follows :—

(1) Mr. P. F. Prunty with 2 native triangulators, 12 traversers and 5 computers in Pakôkku district.
(2) Mr. C. C. Byrne with 10 surveyors in the reserved forests of the Lower Chindwin Forest division.
(3) Mr. J. H. Williams with 11 surveyors in the reserved forests of the Yaw and Lower Chindwin Forest divisions.
(4) Munshi Amjad Ali with 13 surveyors in the reserved forests of the Thaungyin and Thayetmyo divisions.
(5) Surveyor Moung Kyaw Nyein with 5 surveyors in the reserves of the Lower Chindwin division. Mr. S. Fielding on return from sick leave at the end of March took over charge of this camp.

169. Subsidiary triangulation based on the Manipur Minor Meridional Series was carried out in standard sheets Nos. 84 $\frac{J}{4, 8}$, 84 $\frac{K}{1 \text{ to } 8}$ for the purpose of supplying points for the 2-inch topographical survey of these sheets, the triangulation extended over an area of about 1,622 square miles. Mr. Prunty, assisted by two native triangulators, carried out the triangulation in addition to supervising the traverse work.

170. It was found necessary, owing to the greater portion of the area being thickly wooded, to run 881 linear miles of theodolite traverses. These traverses were principally confined to forest boundaries and the main valleys. The theodolite was on an average set up 13 times in the mile. Nearly all the traverses were set up and proved in the field.

171. Topographical survey on the 4-inch scale was carried out over an area of 682 square miles in the reserved forests of the Yaw, Lower Chindwin, Thayetmyo and Thaungyin divisions. Owing to the wooded nature of the country the slow and laborious method of plane table traversing had as usual to be adhered to, and few opportunities occurred of working by interpolation. Food depôts were formed, as formerly, for the purpose of supplying the establishment working in the reserves, but owing to better communications little difficulty was experienced this year in rationing these depôts, except in the Patôlon Extension II and Mepalè-Thaungyin reserves.

172. The area topographically surveyed was examined by one linear mile of test line to every one and three-quarters square miles of 4-inch survey.

173. The health of the party was good except in the Thaungyin division where fever and dysentery were prevalent.

174. The triangulation and traverse computations and fair mapping are all up to date. Thirty-one sheets have been submitted for publication during the year under report and 27 have been published.

175. The total expenditure of the party for the year was R1,52,254 as compared with R1,47,546 for the previous year. The increase is due to the extra expenditure which had to be incurred on the 4-inch detail survey of the Mepalè-Thaungyin reserves. R71,704 of the total is chargeable to the Forest department.

176. The following table gives the outturn and cost-rates for the year under report and the two preceding years:—

Description of work.	Outturn.			Cost-rate *per* sq. mile.		
	1903-04.	1904-05.	1905-06.	1903-04.	1904-05.	1905-06.
				R	R	R
Triangulation . . .	610	800	1,622	7·4	7·8	9·1
Traverse . . .	948(*a*)	976(*a*)	881(*a*)	44·5(*b*)	44·5(*b*)	42·6(*b*)
Topography 4 inch=1 mile .	671	680	682	135·7	142·5	147·7

(*a*) Linear miles of Traverse survey.
(*b*) Cost-rate *per* linear mile.

The triangulation cost-rate, although higher than that of the previous season, is not excessive, and but for abnormal weather during March and April when the work was practically at a standstill, would have been much lower. The traverse cost-rate was normal and satisfactory. The cost of the 4-inch topographical survey has increased by R5 *per* square mile. This rise was solely due to the expensive nature of the work in the reserves of the Thaungyin division. These dense and unhealthy forests necessitated the strengthening of all the plane tablers' squads, and a considerable additional expenditure was incurred for the carriage of food supplies for the establishment in this sparsely inhabited country. The cost-rate *per* square mile for the Thaungyin area by itself amounts to over R154, whereas that of the Chindwin work is R142.

177. The following is the programme for season 1906-1907:—

1. Triangulation and traverse survey of degree sheet 78 P chiefly in the Sylhet district of Assam, in preparation for its topographical survey on the 2-inch scale.

2. The Topographical survey on the 2-inch scale of standard sheets Nos. 84 $\frac{J}{4, 8}$, 84 $\frac{K}{1, 2, 5, 6}$ district Pakôkku, Upper Burma, excluding those small areas already surveyed on the 4-inch scale.
3. Topographical survey on the 4-inch scale of an area of about 50 square miles of forest reserves, Thaungyin.
4. A plane-table survey on the 4-inch scale of the boundaries of the reserved forests of the Minbu division.

178. The Superintendent, Forest Surveys, inspected the party in the field during the month of February and in recess in August.

CADASTRAL AND TRAVERSE SURVEYS.

BENGAL.

179. The operations in Bengal remained under the supervision of Major R. T. Crichton, I.A., Superintendent, Provincial Surveys.

The outturn of the season was as follows :—

	Square miles.
Traversing	6,179
Cadastral Survey	1,814
Record writing	1,601
Topographical survey	1,050
Traverse for topographical survey	1,050

Major Crichton inspected all the parties and camps several times during the field season and once again during recess. He inspected the Bengal Drawing Office frequently during the year and also the office of the Calcutta Suburbs Survey.

NO. 4 PARTY (BIHAR).

180. This party consisted of one traverse and two cadastral camps and was employed mainly in the Purnea, Bhágalpur and Monghyr Districts.

Personnel.

Captain F. C. Hirst, Officiating Deputy Superintendent, 2nd grade, in charge.
8 Writers and Accountants.

Traverse.

Mr. C. S. Gasper, Extra Assistant Superintendent, 4th grade.
Mr. C. A. O'Donel, Extra Assistant Superintendent, 6th grade.
Mr. F. W. Marten, Sub-Assistant Superintendent, 1st grade.
Mr. A. B. Smart, Sub-Assistant Superintendent, 2nd grade.
1 Supervisor, 2 Hospital Assistants, 42 Traversers, 45 Computers, etc.

Cadastral.

Mr. C. S. Kraal, Extra Assistant Superintendent, 2nd grade.
Mr. N. Bedford, Extra Assistant Superintendent, 4th grade.
Mr. J. H. Murphy, Extra Assistant Superintendent, 5th grade.
Mr. J. C. Lears, Sub-Assistant Superintendent, 1st grade.
Mr. O. J. H. Hart, Sub-Assistant Superintendent, 1st grade.
Mr. P. Kennegy, Sub-Assistant Superintendent, 1st grade.
Mr. T. F. Kitchen, Sub-Assistant Superintendent, 3rd grade.
3 Supervisors, 62 Inspectors and 850 detail surveyors.

The somewhat high cost rate for traversing in Bhágalpur is due to the hilly and undulating nature of the country, the remaining traversing rates are fair. The rates for cadastral survey and record writing are good. Topographical rates are good, but since the scale used is the 16-inch, they cannot be compared with last year's rates; the procedure in dealing with topographical work is the same as that adopted during the last two years, with the exception of such modifications as the increase of scale has rendered necessary.

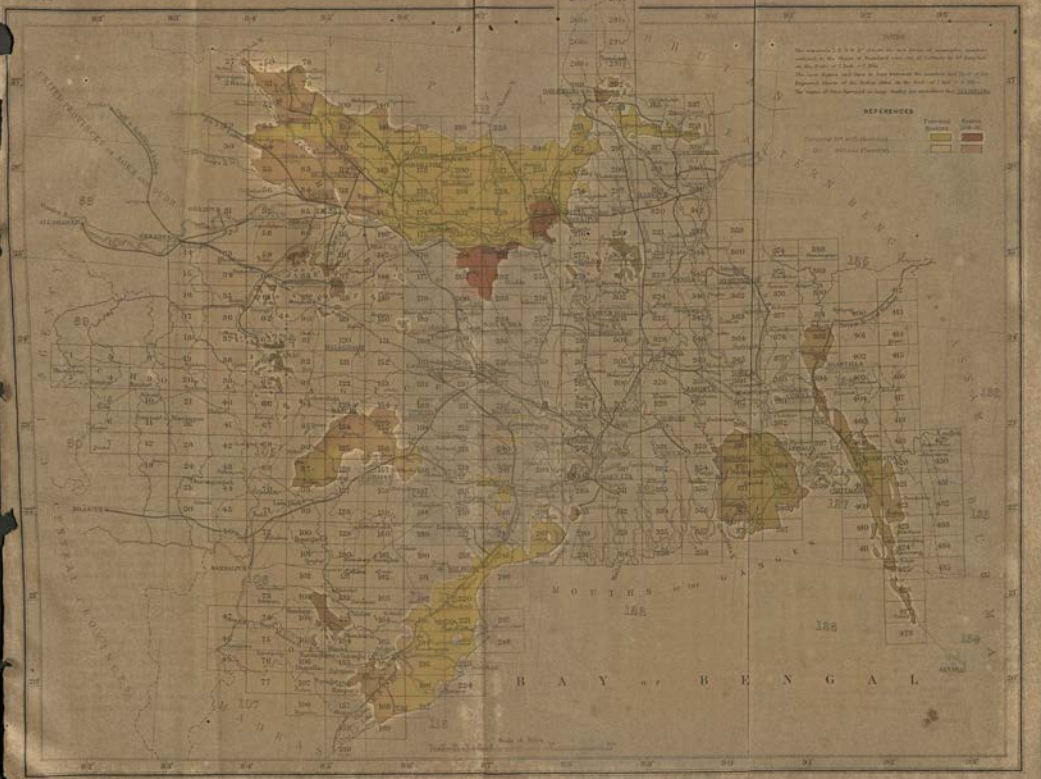
The traversing has been connected with the Great Trigonometrical Survey wherever possible and proves well. There were 36,065 theodolite stations, which were marked with 1,997 stones at trijunctions, 31,149 cylinders and 2,919 pegs. Demarcation on the whole was fair. The detailed survey was checked by 4·7 linear miles of test survey *per* square mile of detail and over 30 *per cent.* of the entries in the records were checked by the Survey staff.

BENGAL.

INDEX TO CADASTRAL SURVEYS.

1905-06.

No. 4, 5, & 6 PARTIES.



Reg. No. 184-5. 07.

INDEX TO TRAVERSE SURVEYS

Reg. No. 244-S. 07.

181. The outturn for the season was as follows :—

District.	Nature of operations.	Area in square miles.	Cost-rate per square mile.
			Rs.
Bhágalpur	Traversing for Cadastral Survey	365	44·7
	Cadastral Survey	1,276	76·1
	Record writing	1,108	58·6
Purnea	Traversing for Cadastral Survey	37	33·8
	Traversing for Topographical Survey	33	20·0
	Cadastral Survey	485	73·5
	Record writing	485	45·7
	Topographical Survey (16 inches = 1 mile).	23	10·0
Monghyr	Traverse for Cadastral Survey	1,217	31·2
	„ „ Topographical Survey	275	...

No. 5 PARTY (CHOTA NAGPUR).

Personnel.

Captain F. C. Hirst, I.A., Assistant Superintendent, 1st grade, in charge to 5th November 1905.

Captain L. C. Thuillier, I.A., Officiating Assistant Superintendent, 4th grade, in charge from 18th November 1905 to 26th February 1906.

Mr. T. W. Babonau, Extra Assistant Superintendent, 4th grade, in charge from 27th February 1906.

Traverse.

Mr. T. W. Babonau, Extra Assistant Superintendent, 4th grade.

Mr. H. A. Hardless, Sub-Assistant Superintendent, 2nd grade.

Mr. L. B. Fitz Gibbon, Sub-Assistant Superintendent, 2nd grade.

1 Supervisor, 50 Traversers and 25 Computers.

Cadastral.

Mr. H. W. Biggie, Extra Assistant Superintendent, 5th grade, to 16th October 1905.

Mr. P. F. Delaney, Sub-Assistant Superintendent, 1st grade, to 16th October 1905.

Mr. A. B. Smart (Junior), Sub-Assistant Superintendent, 3rd grade, to 16th October 1905.

4 Supervisors.

182. This party had only one traverse camp. The operations were carried on in the districts of Midnapore, Singhbhum, Ranchi and Sonthal Parganas. The two cadastral camps were transferred to the Settlement Department on 16th October 1905.

The traversing has been connected with the Great Trigonometrical Survey. There were 48,839 theodolite stations, of this number 4,943 were trijunctions marked by stones and the remaining 43,896 were marked by cylinders, pegs and country stones. The cost-rate for traversing is low considering the hilly nature of the areas in districts Singhbhum and Ranchi, where the subtense bar was constantly used. Demarcation in the Sonthal Parganas was fairly good, no demarcation was done in the other districts. As there are no old maps showing village boundaries the surveyors had to survey the villages as pointed out locally.

The areas traversed are as follows :—

District.	Nature of operation.	Area in square miles.	Cost-rate per square mile.
			Rs.
Midnapur	Traversing	187	31·5
Singhbhum	Do.	573	35·1
Ranchi	Do.	873	34·4
Sonthal Parganas	Do.	797	33·8

No. 6 Party (Eastern Bengal).

Personnel.

Mr. A. W. Smart, Extra Deputy Superintendent, in charge.
Mr. C. H. G. Johnson, Extra Assistant Superintendent, 4th grade.
Mr. E. G. Hardinge, Extra Assistant Superintendent, 6th grade.
Mr. O. E. C. Judd, Sub-Assistant Superintendent, 1st grade.
Mr. P. F. Delaney, Sub-Assistant Superintendent, 1st grade.
Mr. I. Newton, Sub-Assistant Superintendent, 3rd grade.
2 Supervisors, 55 Traversers, 35 Computers and 22 Surveyors.

183. This party comprised one traverse camp, and one camp employed on both traversing and topographical survey.

The outturn for the season is as follows:—

District.	Nature of operations.	Area in square miles.	Cost-rate *per* square mile.
Dacca	Traversing for cadastral surveys	1,638	41·2
Khulna	Ditto ditto	106	44·7
24-Parganas	Traversing for topographical survey	1,050	49·0
	Topographical survey	1,050	37·8

In addition to the above, in district Dacca 698 acres were cadastrally surveyed with a record-of-rights for land acquisition purposes at a cost of ₹515. A traverse survey was also made of the Provincial boundary of districts Backerganj, Faridpur and Khulna at a cost of ₹275.

184. In the traversing of Dacca there are 39,290 theodolite stations marked with 6,083 stones, 6,026 galvanized iron cylinders, 1,014 glazed earthen cylinders and 25,267 pegs. The chaining represents 7,240 linear miles and 221 azimuths were observed to check the angular work. There was absolutely no demarcation of the village boundaries, and no assistance was rendered by the landlords and tenants. The southern and western portions of the area surveyed were low-lying and intersected by large rivers, creeks, and marshes, to the north and east the country was higher and partly covered with low scrub jungle. The cost-rate is very fair considering the nature of the country.

185. The operations in Khulna comprised the traversing of the Dehi Bhadra Estate situated in the north-west corner of the district. Azimuth observations were taken at 29 stations, and there are 2,255 theodolite stations marked with 279 stones, 49 galvanized iron cylinders and 1,927 pegs. The Estate is very swampy and intersected with small streams. The Dalbhanga marsh covers a large area on the south-east. The cost-rate for such a small and detached area is good.

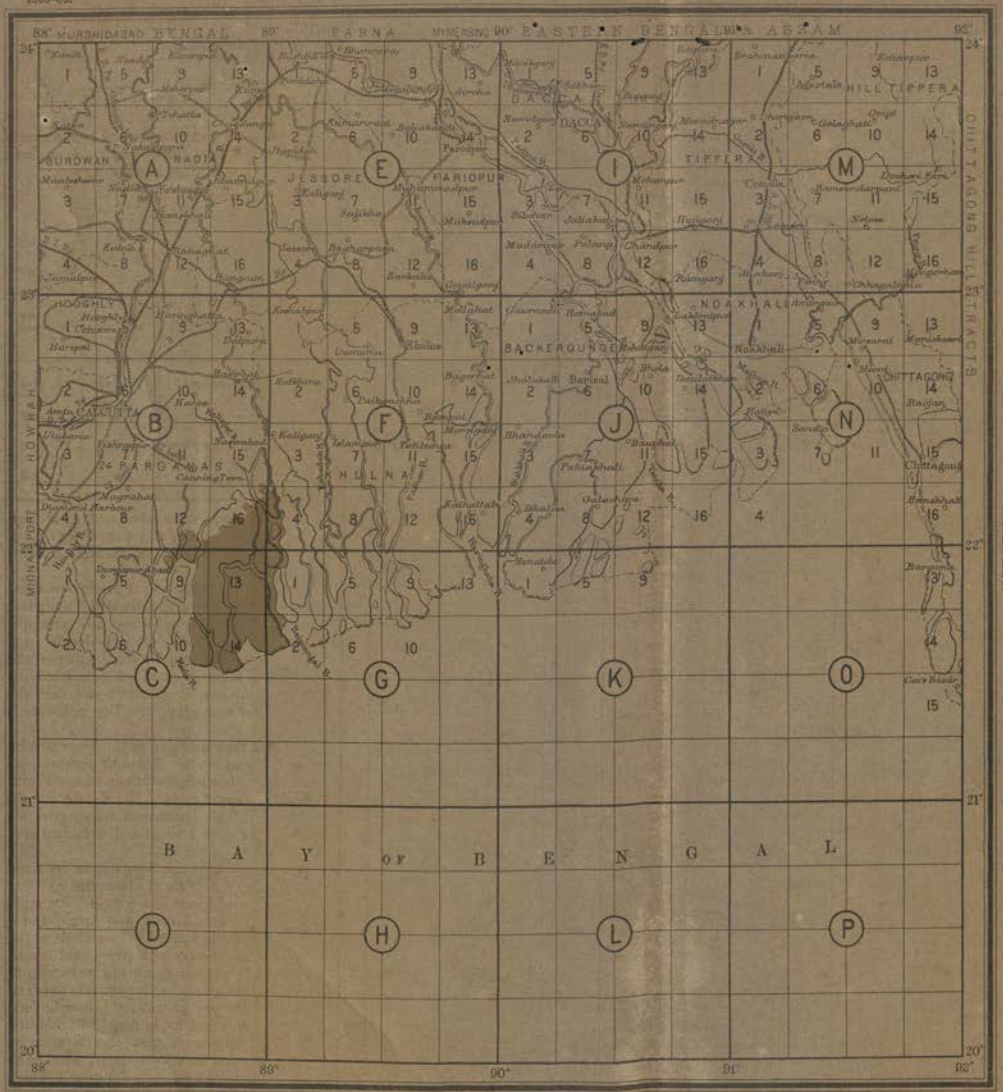
186. The combined operations in the 24-Parganas Sundarbans involved exceptional trouble and anxiety. At the outset, 366 *khalasis* absconded as they refused to live in boats and to work in the dense forest and jungle. Arrangements were then made for recruiting men at Calcutta, Gonda and Arrah, and it was not till the 1st January 1906 that work was fairly started. The whole of the area traversed and topographically surveyed was a network of rivers and creeks covered with dense impenetrable jungle. The system of zig-zag traversing of rivers, streams and creeks was again adopted this season with complete success. There are 3,571 theodolite stations marked with 393 galvanized iron cylinders, 294 trunks of trees cut off at the required height, and 2,884 pegs. In addition cross sticks painted white were fixed over the stations for easy identification by the detail surveyors. A steam launch, a barge, and 80 country boats were hired for the establishment to live in, and for the supply of fresh water and food, which had to be obtained from Calcutta and Canning Town. Great difficulty was experienced throughout the season in keeping the men from absconding, owing to their being compelled to live in boats, and from their fear of being carried off by tigers.

SHEET No. 79.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.



NOTE.

1. The number in the margin is that of the Sheet of the India and Adjacent Countries series on the Scale of Eighteen.
2. The letters denote the Degree Sheets on the Scale of 1 Inch = 4 Miles contained within the Sheet, while the small figures denote the numbers of the 1 Inch Sheets contained in each Degree Sheet.
3. When ordering a sheet on the Eighteen Scale, cut the number given in the margin, should be given e.g. No. 31 in the case of a Degree Sheet, the number in the margin and the Degree Sheet letter must be given e.g. 33A. For a 1 Inch Sheet the number in the margin, the Degree Sheet letter and the 1 Inch Sheet number must be quoted e.g. 33 C.

Published under the direction of Colonel F.B. Lowe, R.E., Surveyor General of India.

1907

Scale 1 Inch = 16 Miles

Miles 10 0 10 20 30 40 50 Miles

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1. Degree Sheets contained on the 1 Inch Sheet.
2. Degree Sheets contained on the 1 Inch Sheet.
3. Degree Sheets contained on the 1 Inch Sheet.
4. Degree Sheets contained on the 1 Inch Sheet.
5. Degree Sheets contained on the 1 Inch Sheet.
6. Degree Sheets contained on the 1 Inch Sheet.
7. Degree Sheets contained on the 1 Inch Sheet.

Reg. No. 243-S. 07.

187. The topographical survey in the 24-Parganas Sunderbans comprised an area of 456 square miles surveyed on a scale of 4 inches = 1 mile, and 594 square miles on the scale of 2 inches = 1 mile. The establishment suffered severely from malarial fever, dysentery and skin diseases; 12 men died during the season, of whom one was killed by a tiger. The cost-rates are very good considering the difficult nature of the country, the heavy expenditure for boats, etc., and the high salaries paid to the establishment.

BENGAL DRAWING OFFICE.

188. During the year under report the work in the Bengal Drawing Office has been heavier and more varied than before, and owing to the increase of work and the need of more accommodation both the photo. room and grainer's shed have been doubled and two portable iron sheds have been erected.

Standard maps.—Seven sheets of Bihar were completed and submitted to the Surveyor General's office for publication and 61 sheets are in hand. This large number of sheets has been taken up with the object of facilitating the preparation of district, *thána* and trijunction-mark maps.

District maps.—The district maps of Puri and Champaran were completed and sent for publication and those of Darbhanga and Chittagong are nearing completion.

Traversec harts.—Four charts of the Orissa division have been completed and 53 are in hand; the charts of Bihar district will shortly be commenced.

Thána and trijunction-mark maps.—The *thána* map, which is prepared on the 1-inch scale, in connection with the *thána* jurisdiction list of villages, shows village boundaries in outline, all village numbers, such village names as can conveniently be fitted in, railways, main roads, canals, rivers, and other main water channels. The trijunction-mark map on the 2-inch scale shows village boundaries in outline and all permanent marks by their proper symbols and with serial numbers; all *thána* numbers of villages are given and such names as will conveniently fit in, but the topographical details of the *thána* map are omitted. Both these maps are compiled for the local Government. The trijunction-mark maps of 77 *thánas* of the Orissa division and Bihar have been completed during the year; 68 of these have been reproduced and 922 copies of them supplied to district officers. Those of 12 *thánas* of districts Bhágalpur, Monghyr, Singhbhum and Tipperah have been commenced and are in hand. Twenty *thána* maps of districts Cuttack, Darbhanga, Monghyr, Bhágalpur, Singhbhum and Chittagong have been completed and 200 copies of each have been supplied; those of the Surjapur pargana of district Purnea have been commenced. Traces for reproduction have also been made from originals supplied by the Special Officer for the Revision of Boundary Commissioner's lists of 112 *thána* maps of 11 districts.

Reproduction of Village maps.—During the year 6,509 paper traces have been prepared from original sheets for reproduction, 10,875 have been examined, 543,101 copies have been printed and 455,295 despatched. Two hundred copies of each of the 396 *thána* maps of 30 districts have been reproduced from originals and supplied to the Special Officer for the Revision of Boundary Commissioner's lists. Two hundred copies each of 8 wall maps and 50 copies each of 79 town maps and one copy each of 155 cadastral sheets have also been reproduced. This section has also touched up 953 sheets for reproduction; compared the original maps of 840 villages of Bihar against Settlement traces, corrected 3,086 copies of 1,354 villages of district Balasore and 157 traces of 144 villages of the Banki Government Estate according to Settlement traces.

Badar Section.—The "*badars*" of 1,161 villages of Bihar, and of districts Midnapur, Ranchi and Backerganj have been corrected during the year. Headings and adjoining names have been corrected on 5,486 cadastral sheets of Bihar and village names on the 4-inch sheets of 141 villages. *Thána* numbers have been entered and names corrected of 4,838 villages in traverse volumes and 3,532 villages in traverse field books. Village names in headings and adjoining sheet numbers have been entered in 2,489 sheets of district Ranchi and Revenue Survey numbers in 2,136 sheets of districts Singhbhum and Midnapur, the originals being received incomplete in these respects. *Thána* lists have been completed for 6,546 villages of Bihar, and 2,834 16-inch maps of district Backerganj of 1903-04 were also touched up for reproduction.

Map Record Section.—Fifteen thousand two hundred and sixty-nine original sheets have been received during the year for record, making a total now of 96,861 sheets in this section—21,522 traces are now also stored in this section and others are being transferred gradually from the reproduction section. A proposal with estimates is now before the Board of Revenue for the erection of a separate fire-proof record room for this section.

MISCELLANEOUS SURVEYS.

189. *Calcutta Municipality.*—The work in this area was conducted under Mr. R. B. Smart, Extra Deputy Superintendent (retired), the operations being confined to the same area as last season, the principal work was the demarcation of holdings within and without the municipal limits and was a tedious operation, the more so as numerous detached holdings although borne in the Collector's Register have not been located, and apparently their existence is not known except on paper as there is no map showing the position of detached lands. Besides demarcation, settling of boundary disputes had also to be attended to in the field. The area traversed for locating detached holdings was—(*a*) 951 acres for survey on 50 feet to the inch, and (*b*) 493 acres on the scale of 32 inches to the mile, (*c*) the detail survey of 40 acres was completed on the scale of 50 feet although a larger area had to be surveyed in skeleton to determine the detached holdings, (*d*) the detail survey of 227 acres and its demarcation on the scale of 32 inches to one mile. Of the 393 fair maps to be completed, 253 have been drawn in skeleton, *i.e.*, all details have been shown, leaving the boundaries to be completed after attestation, and when the records of an entire Sub-Division are returned the maps are inked up.

190. *Patna Division Diara Survey.*—In paragraph 224 of last year's report mention is made of a proposal to mark permanently selected points in the Ganges *diara*. During the year under report 288 marks were laid down. Of these 99 were on islands and high sand banks and consisted of heavy 10-foot scantlings with cross feet arranged so as to give the marks, when buried about 5 feet deep, sufficient purchase to withstand considerable water pressure. The marks along the edges of the *diara* tract have mostly disappeared proving that the existing permanently marked lines bounding the *diara* cannot be drawn closer together with safety. The examination of the marks on islands and sand banks cannot be undertaken till the river has fallen.

191. *Darjeeling-Nepal Boundary.*—Mr. C. A. O'Donnel was deputed to relay this boundary which was disputed in several places and lies chiefly along the Mechi river. One hundred and twenty points at the main bends of 51 linear miles of boundary have been temporarily marked. The permanent marking will be undertaken by the local officials. Mr. O'Donnel's maps have been sent to the Deputy Commissioner of Darjeeling.

192. *Bhágalpur-Nepal Boundary.*—Several pillars and posts having been reported to be missing, steps were taken to replace them. During the year 20 selected points have been marked with stout wooden posts, but the experience of several seasons shows that no satisfactory permanent demarcation of the boundary can be expected in this tract as the Kosi River changes its course every year.

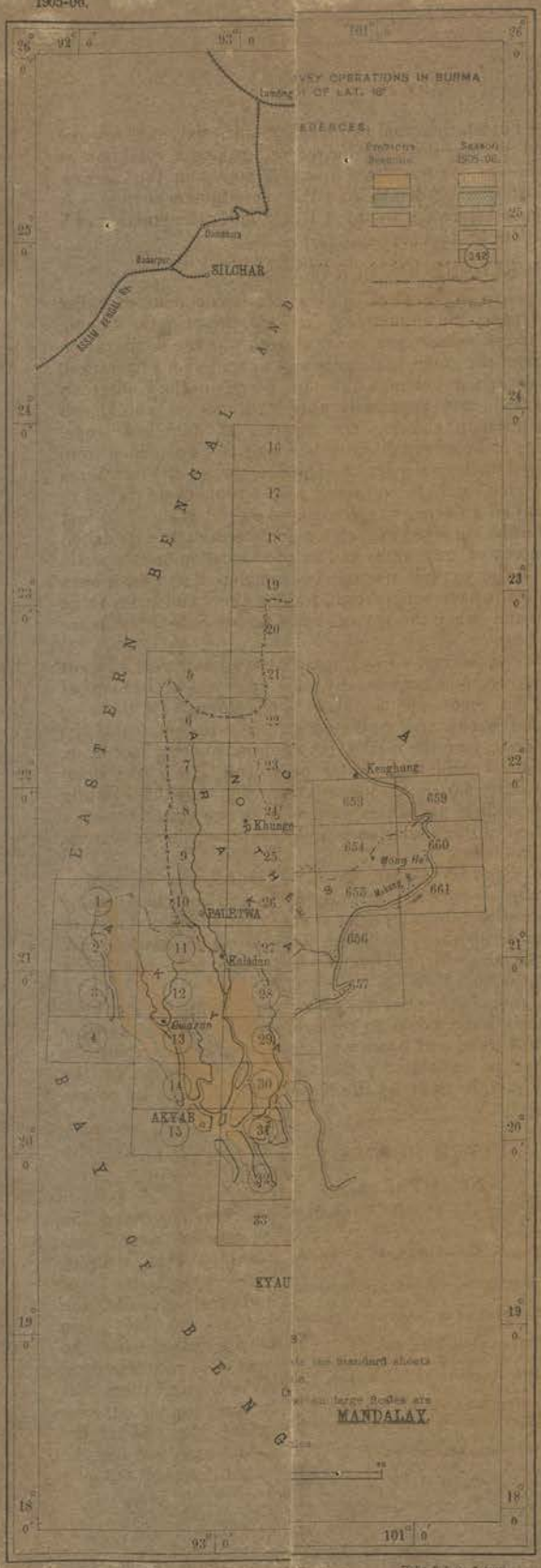
UPPER BURMA.

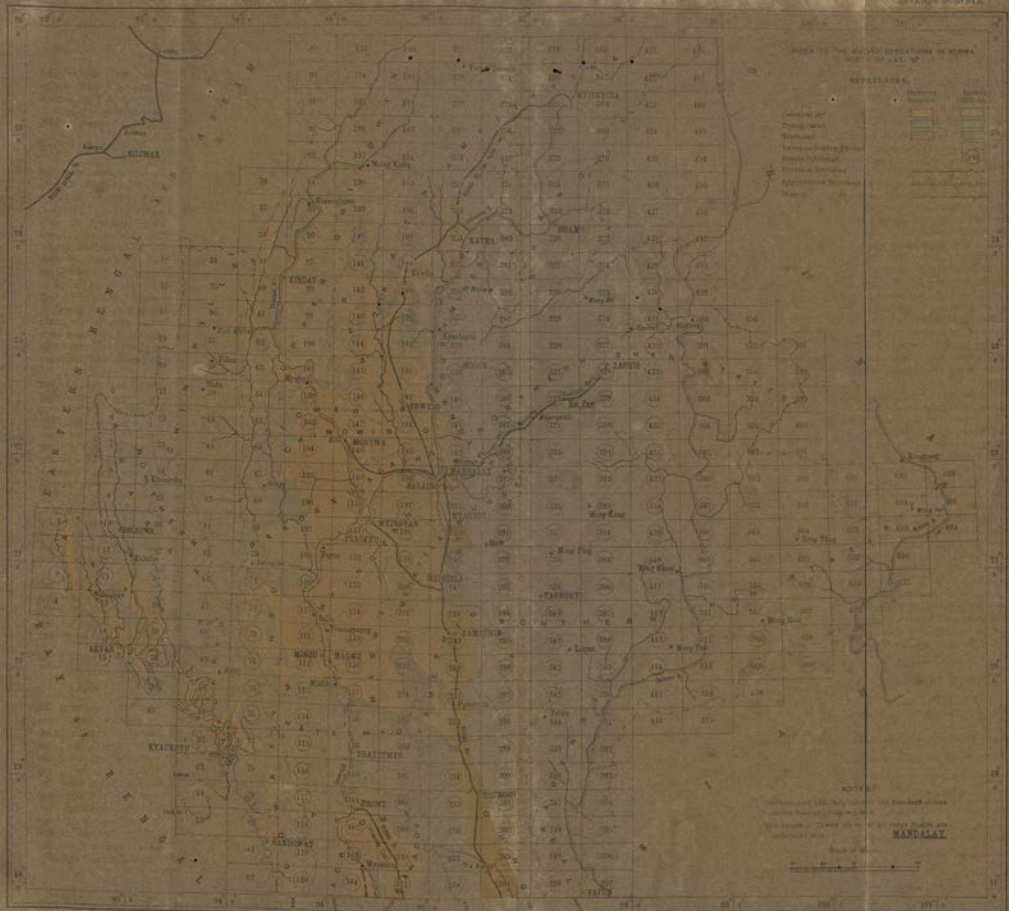
No. 7 PARTY.

193. The cadastral survey of the Pakokku district was continued and the operations were confined to that district. The programme of cadastral survey for the season was only 900 square miles, but the area surveyed contained so little cultivation that it was completed long before the end of the field season and as the establishment is virtually

Personnel.

Major C. W. H. Symonds, I.A., Deputy Superintendent, 1st grade, in charge up to 26th September 1906.
Mr. J. S. Swiney, Extra Assistant Superintendent, 2nd grade, up to 18th December 1905.
Mr. O. D. Smart, Extra Assistant Superintendent, 3rd grade, in charge from 27th September 1906.
Mr. C. G. Lee, Extra Assistant Superintendent, 4th grade.
Babu Jagdamba Prasad, Extra Assistant Superintendent, 6th grade.
Babu Abinash Chandra Bose, Extra Assistant Superintendent, 6th grade, *sub. pro tem.*
Mr. C. S. Littlewood, Extra Assistant Superintendent, 6th grade.
Mr. S. F. Norman, Sub-Assistant Superintendent, 1st grade, from 30th January to 3rd August 1906.
Mr. W. E. Swiney, Sub-Assistant Superintendent, 2nd grade.


VEY OPERATIONS IN BURMA
OF LAT. 18°
EDENCES.
Season 1905-06.
SILCHAR
Kenghung
Khunge
PALETWA
Kaladan
AKYAB
KYAU
MANDALAY.
EASTERN BENGAL AND
BAY OF BENG
93° 0'
101° 0'


1905-06.
BURMA
REVENUE SURVEY.
REFERENCES.
MYITKYINA
KATHA
SHAMO
KINDAT
MOGOK
LANGIO
SHWEBO
MONYWA
MANDALAY
PAGAING
MYINGYAN
PAKOKKU
MEIKTILA
YAMETHIN
MINGU
MAGWE
KYAUKSEU
THAYETMYO
PROME
SANDOWAY
PAPUN
AKYAB
SILIMAK
EASTERN BENGAL AND ASSAM
BAY OF BENGAL
NOTES
MANDALAY
Reg. No. 356-5, 07

guaranteed employment for at least 6 months, field work was continued after the programme had been completed and resulted in the following outturn :—

	Traversing.			Detail survey on 16-inch scale.						
	Kwins.	Square miles.	Cost *per* square mile.	*Kwins.*	Sheets.	Fields.	Acres.	Square miles.	Cost *per* square mile.	Average size of fields in acres.
			R			(*a*)	(*a*)	(*a*)	*R*	(*b*)
Cadastral	279	535	91	557	1372	198,498	710,879	1,095	95·5	0·89
Topographical	11	13		7	23	...	...	16		
Water area	...	...	...	...	...	...	37,760	59	...	...
Total	290	548	...	564	1395	198,498	748,639	1,170		

(*a*) Includes jungle.
(*b*) Calculated on the cultivated area only.

194. Field work commenced on the 10th November 1905 and closed on the 21st April 1906. The traversing of the whole area which is to come under survey of the Pakôkku district was completed. The country traversed was mostly hilly and covered with scrub jungle and there were very few villages and roads. Water was scarce in the north-east portion of Pauk township at the end of the field season, and fever was very prevalent during November and December. The average number of traversers was 11 for $5\frac{1}{2}$ months and owing to the difficult nature of the country their daily average outturn was only 12 angles and 124 chains. Double chaining was employed in all circuits and the total length of the traverses was 1,262 linear miles. No Great Trigonometrical Survey stations were sufficiently near to allow of connections being made this season, but sufficient connections had been made in previous seasons and in the adjoining Lower Chindwin district to check the traversing. The average linear error *per mille* for the season is 0·51 link and 11·48 feet *per* mile for the whole district. This latter is a large error, and is due to the difficult nature of a large portion of the area traversed, and also to the fact that at the time the greater part of the traversing was done there were no trigonometrical stations to connect with, the triangulation having been done subsequently by No. 10 party. The theodolite was set up at 11,346 stations of which 10,096 were new and were all marked with galvanized iron cylinders, at an approximate cost of 14 annas per station. Azimuths were observed at 62 stations and vertical angles at 1,569. The origin of survey was the same as that of previous seasons.

195. The cadastral survey was carried out by 2 camps. The average number of *amins* employed was 87 for 140 days with 10 Inspectors. The area surveyed cadastrally lay mainly in the Seikpyu township but a portion fell into the Pakokku and Pauk townships. Only 259 square miles consisted of cultivated land which contained 184,747 fields of an average size of 0·89 acre. The rest of the area, 736 square miles, consisted of jungle in which no details were surveyed, the traverse lines being accepted as the boundaries of the *kwins*. The work was checked by 360 linear miles of test lines by Imperial and Provincial officers, and 252 linear miles of independent lines, which give an average of 2·4 linear miles of test survey to each square mile cadastrally surveyed in addition to the Inspectors' check lines. The small area that was surveyed topographically consisted of land in the bed of the Irrawaddy which is subject to periodical inundations, and following the practice of former seasons, only the *kwin* boundaries, limits of cultivation, water-channels and the sites of villages which are occupied during the dry season were mapped. The original maps of this area, 23 in number, have been handed over to the Deputy Commissioner and no copies have been printed.

196. The 16-inch maps were all completed and sent to Calcutta for reproduction with the exception of the 23 mentioned above and those of 42 *kwins* on 136 sheets which have also been sent direct to the Deputy Commissioner, as they contain no interior details and no copies will be printed of them at present. No printed copies of any of the 16-inch maps had been furnished to the local authorities up to the end of the season. The whole of the season's work has been added to the 2-inch fair maps which have been in progress for several seasons,

and all of which have been despatched to head-quarters except sheets $84\frac{K}{1,2,11,11}$ which have been retained as the work of the ensuing season has to be added to them. All these maps have been prepared in the old form. The 3 sheets of arrears 2-inch mapping of the Shwebo district alluded to in paragraph 232 of last season's report, have all been submitted to head-quarters and also 1 sheet of the Pakokku district. During this season 36 traverse charts have been completed on the 1-inch scale and five sent to Calcutta for publication. The Deputy Surveyor General inspected the party at Maymyo to which place the recess quarters of the party have been moved.

197. The cost-rates all include a charge for instruments. That of the cadastral survey is considerably lower than it was last season when it was R114. This is due to the larger area surveyed this season and the small amount of cultivation in it. The cost of the traversing shows a rise of R33 per square mile which is attributable to the smaller area traversed, the more difficult nature of the country, and much sickness amongst the traversers during November and December.

198. During the ensuing season the cadastral survey of the Pakôkku district will be completed, the area remaining for survey being 514 square miles, and 600 square miles will be traversed in the Thayetmyo district, where an area of 2,150 square miles in the Minhla and Sinbaungwè townships is to come under survey. The traversing and cadastral survey of 200 square miles in the Pyapôn district will also be done.

CANTONMENT SURVEYS.

No. 1 SECTION.

199. This was formerly a detachment of No. 15 Party, but was this year placed under the orders of the Deputy Surveyor General. Mr. J. McHatton remained in charge with an establishment of 11 surveyors, 3 computers and 2 draftsmen. During the season the survey of the following 15 cantonments was completed on the scale of 16 inches to the mile. Their bazaars were surveyed on the scale of 64 inches to the mile:—Murree (comprising 6 cantonments), Campbellpore, Kohat, Roorkee, Subathu, Kasauli, Jutogh, Dagshai, Solon and Bakloh. The cantonments of Nowshera, Abbottabad, Dalhousie and Delhi were partly surveyed. The total areas traversed and surveyed and the cost-rates *per* acre were:—

	Acres.	Cost-rate.
Traversed	11,393	R 0·4
Surveyed on the 16-inch scale	8,020	„ 1·4
„ „ 64 „ „	162	„ 0·5

200. Many of the cantonments are situated in the hills and the work was much interfered with by rain. Delays occurred at the commencement of the season owing to changes in the programme having to be made at the request of the military authorities. The survey of Abbottabad was completed but additions and alterations are now being made to the cantonment and these will be inserted on the maps next season if possible. Kasauli also will have to be revisited, although the survey was completed this season, as the boundary was not demarcated at the time of survey. The work at Dagshai and Solon consisted of a revision of the surveys of 1878 to 1881.

201. The maps of 10 cantonments and their bazaars, Cherat, Murree (6), Kohat, Campbellpore and Roorkee were forwarded to the office of the Superintendent, Trigonometrical Surveys, for publication and those of 18 cantonments, namely, Amritsar, Ferozepore, Jhelum, Jullundur, Karachi, Lahore Fort, Mian Mir (part), Ambála, Sialkot, Ráwalpindi, Cherat, and Murree (6) were published, as also those of the bazaars of Fyzabad, Meerut, Multan and Cawnpore.

Next season the following cantonments will be surveyed:— Delhi, Muttra, Shahjahánpur, Sitapur, Benares, Dalhousie, Lansdowne, Ranikhet, Almora, Naini Tal and Landour.

No. 2 SECTION.

202. This is a small detachment temporarily formed in December 1905 for the survey of 18 military cantonments and their bazaars in the Poona and Mhow divisions of the Western Command. The cantonments are being surveyed on the scale of 16 inches to the mile and the bazaars on the 64-inch scale. The cantonments of Poona, Kirkee, Deolali, Purandhar, Baroda, Ajmere, and Khandala were surveyed in outline but the contouring still remains to be done; Mount Abu, Ahmedabad and Nasirabad were also partly surveyed. The total area surveyed on the 16-inch scale was 10,397 acres and 379 acres on the 64-inch scale. Work was carried on throughout the season, the detail survey having been commenced about the 1st February 1906. No cost-rate can be given as the mapping of no cantonment was completed owing to orders to show contours on the maps having been given very late in the season.

Personnel.

Mr. E. G. Little in charge till 17th August 1906.
Mr. L. J. Pocock in charge from 18th August 1906.
2 Inspectors, 2 Traversers, 7 Surveyors, 2 Computers, 5 Draftsmen.

The Deputy Surveyor General inspected the section at Poona in July and tested some of the work in progress there.

During the ensuing season the cantonments already partly surveyed will be completed and the survey of Ahmednagar, Aurangabad, Neemuch, Sehore, Mhow and Indore will be taken up, leaving Jubbulpore and Pachmari for survey the season after.

No. 3 SECTION.

203. This section was formed this season for the survey of the cantonments of the 9th (Secunderabad) Division including the civil station of Bangalore. Work commenced in February 1906 and continued throughout the year. The survey of the cantonments of St. Thomas' Mount, Poonamallee, Palláverám and Trichinopoly was completed, but the boundaries not having been demarcated the maps cannot be published and final cost-rates cannot be given; portions of Fort St. George, Bangalore, Wellington and Cannanore were also surveyed. The cantonments are being surveyed on the scale of 12 inches to the mile and the bazaars on the 48-inch scale. The total area surveyed on the former scale was 7,620 acres and on the latter 205 acres, while the total area traversed was 15,112 acres. Five sappers of the Queen's Own Corps of Sappers and Miners were employed on the detail survey.

Personnel.

Mr. L. J. Pocock in charge till 13th August 1906.
Mr. E. G. Little in charge from 14th August 1906.
2 Inspectors, 7 Surveyors, 2 Traversers, 2 Computers, 2 Draftsmen.

204. The Bangalore station and cantonments were surveyed on the 12-inch scale in 1885 and an attempt was made to revise the old maps, but these proved hopelessly out of date and the station has increased so much that an entirely new survey will have to be made and the scale of 16 inches to the mile will be adopted. This will necessitate the retention of the section for another season.

205. The above named 8 cantonments are all that are to come under survey in this Division and they will be completed next season as well as the bazaars of Secunderabad and Bolarum, the total area remaining for survey being 12,482 acres of cantonments and 1,597 acres of bazaar.

The Deputy Surveyor General inspected the section at Bangalore and tested the work there.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 PARTY.

206. The programme for the season was to connect the new Kalat Longitudinal series with the Great Indus series and thus base it on the Principal Triangulation of India. Bad weather was experienced at Zamziri hill station, an early fall of snow occurring on 11th December, and the party was delayed a fortnight in consequence. The triangulation was closed on the base Kharko—Gand Pahar on the 1st March 1906. On completion of the triangulation an astronomical azimuth was observed at Gand Pahar H. S.

Personnel.

Captain H. H. Turner, R.E., Officiating Deputy Superintendent, 2nd grade, in charge up to 25th March 1906.
Mr. J. Eccles., M.A., Superintendent, 1st grade, in charge from 26th March to 6th May 1906.
Lieutenant C. M. Browne, D.S.O., R.E., Assistant Superintendent, 2nd grade, in charge from 7th May 1906 to 6th June 1906.
Major G. P. Lenox Conyngham, R.E., Superintendent, 2nd grade, in charge from 5th June 1906 to 27th June 1906.
Lieutenant C. M. Browne, D.S.O., R.E., Assistant Superintendent, 2nd grade, in charge from 28th June 1906.
Mr. C. D. Simons, Sub-Assistant Superintendent, 2nd grade.
„ C. H. Tresham, Sub-Assistant Superintendent, 2nd grade.
3 Recorders and 1 Writer.

Four trigonometrical figures were completed, seven new stations built and fixed, and one astronomical azimuth observed.

The average triangular error was as follows :—

No. 1	Quadrilateral	0″·352
No. 2	„	0″·409
No. 3	Tetragon	0″·609
No. 4	Quadrilateral	0″·276
	Mean triangular error for 16 triangles	0″·412

The Kalát Longitudinal series and the Mekran series comprise all the Principal triangulation that has been so far completed in Baluchistan. Of the secondary work but little remains, most of the stations having disappeared.

207. To complete the Principal triangulation of Baluchistan the following work remains to be done :—

(*a*) The Kalát and Mekran series must be continued to longitude 64° and there connected by a meridional series.

(*b*) A branch series must be extended westwards from 64° from the Kalat series to Koh-i-Malik-Siah and another from the Mekran series to Charbar: these, it may be hoped, will be eventually connected about longitude 59°.

(*c*) On the east it is proposed to carry a series north-east from Kalat through Toba and Zhob to the Indus.

SCIENTIFIC OPERATIONS.

OBSERVATIONS FOR AZIMUTH.

No. 22 PARTY.

208. As no officer was available for astronomical work, No. 22 party did not undertake a regular programme of field-work during the year 1905, but was employed on miscellaneous duties under the Superintendent of Trigonometrical Surveys.

Personnel.

Lieut.-Colonel S. G. Burrard, R.E., F.R.S., Superintendent, Trigonometrical Surveys, in charge.
1 Surveyor.
1 Computer.

209. From 1802 to the present time rigorous astronomical observations for azimuth have been regularly taken at intervals of 40 or 50 miles along all Series of the Principal Triangulation: no immediate use had, however, been made of the results. The geodetic evidence furnished by the azimuth observations has now been analysed, and an account of the investigation will be published in the forthcoming Professional Volume No. XVIII.

210. When a comparison is made between a value of azimuth calculated through the triangulation and an observed value, the difference is made up of four entangled components :—

1stly.—The *calculated* azimuth has been adversely affected owing to the projection of the triangulation upon a spheroid that is too small.

2ndly.—The triangulation has been started with a wrong orientation.

3rdly.—The triangulation has slowly accumulated an error of direction in its passage across India, and the azimuths calculated from it have become more and more incorrect, as the distance from the origin has increased.

4thly.—The *observed* value of azimuth is in error owing to the deflection of gravity out of the true vertical.

211. Colonel Lambton observed azimuths in order to deduce a figure for the Earth from the discrepancies between his observed and calculated values. Colonel Everest observed azimuths in order to keep a check upon the direction of his triangulation. General Walker regarded azimuthal observations as so many determinations of the directions of gravity.

From the investigation made at Dehra Dún during the year 1905-06 the following errors of azimuth have been found generated in the triangulation at the extremities of the principal Series.

From Kalianpur in Central India to—

Karachi	—2″·3
Dehra Dún	—0″·1
Calcutta	—5″·9
Chittagong	—5″·4
Akyab	—0″·8
Prome	—1″·9
Moulmein	—9″·1
Vizagapatam	—1″·6
Bombay	—2″·4
Mangalore	—4″·5
Bangalore	—5″·9
Madras	—3″·6
Cape Comorin	—8″·6

212. The negative sign denotes that in every part of India the azimuths calculated from the triangulation are too large. The persistency of the sign may be explained by the supposition that the Principal Triangulation has been started from an erroneous azimuth. The side of origin was from Kalianpur to Surantad and this was given an azimuth of 190° 27′ 6″·29, a value derived from astronomical observations. If we decrease the initial azimuth, all geodetic azimuths become decreased by the same amount. Kalianpur is now known to overlie a line of subterranean density, and as the direction of gravity does not coincide with the vertical, it has not proved a suitable site for the origin of the survey. It would, however, be incorrect to take a mean of the above negative differences and to apply it as a correction to the initial azimuth. The error of azimuth generated in the Indian triangulation tends to accumulate in one direction, and the large errors at Moulmein and Cape Comorin are clearly more due to a steady accumulation than to an error of origin. The true azimuth at Kalianpur will have to be deduced from the results of pendulum observations.

213. A Professional Volume containing an account of the Latitude observations taken in India and of the deduced deflections of the plumb-line has been compiled by the Superintendent of Trigonometrical Surveys during the years 1904—1906. The numerous tables were prepared in the first instance in No. 22 party and subsequently checked in the Computing Office. The volume is now complete and will shortly be published. It will be numbered XVIII.

PENDULUM OPERATIONS.

No. 23 Party.

Personnel.

Major G. P. Lenox Conyngham, R.E.
Babu Hanuman Prasad, Extra Assistant Superintendent, 6th grade.
1 Writer and Computer.
1 Surveyor.

214. During the year 1905-06 the work undertaken consisted of a series of pendulum observations at stations lying, roughly speaking, on a line stretching from Simla to Quetta.

The objects of the season's work were—

(1) To ascertain whether the marked deficiencies in gravity which had been observed in the outer Himalayan ranges and the submontane tracts, both on the meridian of Dehra Dún and on that of Darjeeling, would again be found in the neighbourhood of Simla.

(2) To see whether the pendulums would throw light on the deflections of the plumb-line indicated by the Amritsar-Multán arc of Longitude. (On this arc the plumb-lines are deflected inwards, although the position of the Himalaya and the Suleiman mountains would lead one to expect outward deflections.)

(3) To make a first step towards the examination of the plains of Sind and the Baluchistan mountains.

(4) To make a set of observations at Captain Basevi's station at Mian Mir. This was the last station at which Basevi observed before starting on his journey to Moré, and the only one at which he used the special stand which he had constructed for that difficult expedition. It has been thought that this stand may have been less rigid than the ordinary one, and that therefore his observations at Mian Mir and Moré may require a special correction.

215. One of the difficulties of pendulum operations is to ascertain the temperature of the pendulum. To assist in this a dummy pendulum containing a thermometer had been constructed in Calcutta and much was hoped from its use. Its indications, however, proved untrustworthy, though the reason was not at first apparent. Eventually it was traced to the fact that there was too close a connection between the dummy pendulum and the brick pillar on which the apparatus is erected. The pillars are generally only built a few days before the observations begin and are consequently often damp and colder than the air of the room; the temperature of the dummy pendulum is apt therefore to be unduly lowered by too rapid conduction.

It is hoped that steps now being taken will render the dummy pendulum a valuable adjunct.

216. The time observations have been performed throughout by Babu Hanuman Prasad. An innovation was introduced into the method of using the Transit instrument. Formerly it used to be reversed once or twice during a night's work, now it is reversed in the middle of the observation of each star. The new method has several advantages and the results obtained were very satisfactory; the average probable error of the rate of the clock derived from observations of one star on successive nights is ±0·047. This small value testifies not only to the suitability of the method but also to the care and skill of the observer.

217. At no fewer than six of the stations visited it was necessary to compute an orographical correction, that is to say, a correction on account of the irregularity of the surface of the region surrounding the station. Much time and trouble were spent on this subject with a view to rendering the process of calculation more accurate, more systematic and less laborious. A certain amount of success has been achieved but rather in the direction of system than of ease.

218. The results of the season's work are given in the following table:—

Station.	Latitude.	Height above sea level.	Observed g.	g reduced to sea level $= g_o''$.	Theorotical value at sea level $= \gamma_o$.	$g_o'' - \gamma_o$.
	° ′ ″	Feet.	cm.	cm.	cm.	cm.
Simla	31 6 19	7,043	978·842	979·267	979·386	−0·119
Kalka	30 50 8	2,202	979·149	·280	·364	−0·084
Ludhiana	30 55 25	833	·276	·325	·371	−0·046
Pathankot	32 16 33	1,088	·239	·303	·481	−0·178
Mian Mir	31 31 36	708	·385	·426	·420	+0·006
Ferozepur	30 55 48	647	·343	·380	·372	+0·008
Montgomery	30 39 47	557	·323	·356	·351	+0·005
Multán	30 11 11	404	·245	·269	·312	−0·043
Dera Gházi Khan	30 3 49	397	·194	·217	·303	−0·086
Jacobabad	28 16 34	183	·188	·199	·166	+0·033
Sibi	29 32 46	434	·121	·146	·262	−0·116
Mach	29 52 25	3,522	978·962	·173	·288	−0·115
Quetta	30 12 15	5,520	·852	·176	·314	−0·138

219. Turning now to the objects which underlay the choice of stations we find—

(1) At Simla a deficiency very similar to that at Mussooree but considerably less than those at Kurseong, Darjeeling and Sandakphu.

At Kalka a deficiency less than those at Dehra Dún or Siliguri, but at Pathankot one which is markedly greater than has been found anywhere else.

In the following table the figures relating to all these places are collected:—

	Station.	Latitude.	Height.	$g_o'' - \gamma_o$.	Thickness of corresponding disc D.	H — D.
		° ′				
Himalayan.	Sandakphu	27— 6	11,766	−0·147	4,180	7,586
	Darjeeling	27— 3	6,966	−0·143	4,070	2,896
	Kurseong	26—53	4,913	−0·130	3,700	1,213
	Mussooree (Camel's Back)	30—28	6,924	−0·109	3,100	3,824
	„ (Dunseverick)	30—28	7,131	−0·115	3,270	3,861
	Simla	31— 6	7,043	−0·119	3,380	3,663
Submontane.	Siliguri	26—42	387	−0·135	3,840	−3,453
	Dehra Dún	30—19	2,241	−0·121	3,440	−1,199
	Kalka	30—50	2,202	−0·084	2,386	−184
	Pathankot	32—17	1,088	−0·178	5,055	−3,967

At Darjeeling we are within sight of the gigantic peaks of Kinchinjunga and Everest. The theory of isostasy requires that where the elevation of the crust is great, there the density of the subjacent strata must be deficient, but it would be unreasonable to expect a constant relation between height and density to hold good for individual peaks or valleys. The truth of the theory has by no means been demonstrated; at present all that can be said is that there is a tendency indicated in the direction to which it leads; and that wide regions must be considered and not isolated spots. The defects in gravity at the Himalayan stations which have so far been visited seem to show that there is a relation between height and density, though they do not support the theory of complete compensation.

The distances of the four submontane stations from the foot of the Himalayas and from the Siwaliks are not identical and the results obtained may be taken to indicate that much depends upon the exact position of each station and that the force of gravity varies rapidly in the submontane tracts. Further investigation may disprove this, but it is certainly desirable that some region be examined in detail so that a definite idea of the form of the trough which seems to lie along the base of the hills may be gained.

(2) The pendulum observations taken at stations situated on a line running across the plains of the Punjab explain the cause of the inward deflections at Amritsar and Multán. Underlying the plains skirting the mountains on either side of the Punjab there are great deficiencies of density equivalent to troughs: under the centre of the Punjab plains an excess exists equivalent to a buried range. Amritsar and Multan are situated near the hidden excess and its attraction on their plumb-lines is more powerful than the attraction of the distant hills.

(3) The observations in Sind and Baluchistan have the same general characteristics as those near the Himalayas. We find deficiencies in the value of g on and immediately below the hills and an excess further off. The large excess at Jacobabad is noteworthy.

(4) The observations at Mian Mir show an excess in gravity of 0·006, whereas Capt. Basevi's results showed a defect of 0·106. But this difference is mainly accounted for by the difference in the adopted value of g at Dehra Dún.

Basevi's difference between Dehra Dún and Mian Mir is 0·311, the value now obtained is 0·320. The discrepancy of 0·009 is not large and we cannot conclude from it that the new stand employed by Capt. Basevi at Mian Mir and Moré was unsatisfactory.

Basevi's value of $g_0'' - \gamma_0$ at Moré was 0·518, on account of the more recently adopted value of g at Dehra Dún we should be justified in reducing this to about 0·400, but even this value is remarkably high and requires corroboration.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

Tidal Operations.

Personnel.

Mr. C. F. Erskine, Officiating Superintendent, 2nd grade, in charge from 9th January 1906.
Mr. J. P. Barker, Extra Assistant Superintendent, 3rd grade, in charge from 1st October 1905 to 8th January 1906.
Mr. H. G. Shaw, Extra Assistant Superintendent, 4th grade.
„ E. H. Corridon, „ „ „ 6th „
Munshi Syed Zille Hasnain, Sub-Assistant Superintendent, 1st grade.
Mr. A. M. Talati, Sub-Assistant Superintendent, 2nd grade.
„ O. N. Pushong „ „ „ „
28 Surveyors, etc.

220. Observations were taken, by means of self-registering tide-gauges, during the year at the stations enumerated in the following list; the permanent stations are shown in italics :—

	Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1	*Aden*	1879	Still working	26	
2	*Karachi*	1881	„	25	
3	Okha Point	1874	1875	1 } = 3	Closed on 3rd January 1906. Observations between 1904 and 1905 rejected as unsatisfactory.
		restarted 1904	1906	2 }	
4	*Bombay (Apollo Bandar)*	1878	Still working	28	
5	*Bombay (Prince's Dock)*	1888	„	18	Property of Port Trust.
6	*Madras*	1880	1890	10 } =21	
		restarted 1895	Still working	11 }	
7	*Kidderpore*	1881	„	25	
8	*Rangoon*	1880	„	26	
9	*Port Blair*	1880	„	26	

221. In addition to the above, readings to tide-poles were taken at Bhávnagar, Chittagong, Akyab and Moulmein.

222. The 9 tidal observatories at work were inspected during the year: the registrations have been satisfactory at all of them.

223. The tidal observatory at Okha, at the mouth of the Gulf of Cutch, was re-opened in January 1904 and closed in January 1906, after a complete year's satisfactory tidal registrations had been obtained. The tide-gauge was connected by spirit-levelling with Bench-marks the heights of which had been determined by spirit-levelling in 1874. The length of the line relevelled was about 11 miles in the course of which 6 old Bench-marks were connected. The object of these operations was to test whether any change in the relative level of land and sea had taken place in this vicinity during the last 30 years. The mean level of the sea at Okha was first determined from tidal observations in 1874-75. The results of the investigations prove that no such change is discernible in this neighbourhood.

224. In the following tables are given the annual and decadal percentages of the predicted time, and height errors of high and low water at open coast and riverain stations :—

Percentage of errors in Predicted Times and Heights at open coast stations from Automatic Registrations.

Year.	Number of Stations.	In time.		In height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1896	9	71	70	97	97	97	93
1897	8	71	75	96	97	97	97
1898	9	74	70	96	96	95	95
1899	9	74	66	95	95	93	92
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
1905	7	82	79	96	95	96	97
Average of 10 years	9	75	70	95	95	95	94

Percentage of errors in Predicted Times and Heights at Riverain stations from Automatic Registrations.

Year.	Number of Stations.	In time.		In height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1896	2	56	55	63	42	87	74
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
1905	2	52	62	72	57	94	92
Average of 10 years	2	56	60	72	58	92	89

225. The project of re-establishing a tidal observatory at Moulmien has received the sanction of Government, but the question of a suitable site has not yet been definitely settled.

LEVELLING OPERATIONS.

226. During the past year there were two Levelling Detachments at work, and a third is now being organised. Before taking the field both detachments were employed in revising the line of levels from Mussoorée to Kolukhet (8 miles) by double levelling, to check the heights obtained by single levelling in May 1905. The general result of the revision was that a slight subsidence was shown to have occurred at Mussooree, but the actual amount was too small to be measured without laborious repetitions of levelling.

227. During the field season Levelling Detachment No. 1 connected 18 Standard Bench-marks in the United Provinces and 1 at Gwalior, and levelled across the Brahmaputra river to link up the line of levels from Parbatipur to Dhubri with the line from Fakirganj to Gauhati; the outturn of work being 131·1 miles of double levelling and 13·2 miles of single levelling. This detachment left Dehra on 8th November 1905 and returned to recess quarters on 11th April 1906.

228. Levelling Detachment No. 2 was employed in levelling from Sukkur to Shikarpur, and from Lahore to Ráwalpindi along the North-Western Railway, and in connecting the Standard Bench-marks at the two latter stations. The outturn of work amounted to 244 miles of double levelling. This detachment left Dehra on 3rd November 1905 and returned on 24th April 1906.

229. The programme for the coming season will be as follows:—

Detachments Nos. 1 and 3 to be employed on the revision of the line of levels between Bombay and Madras, and connecting Standard Bench-marks *en route*.

Detachment No. 2 to work in the United Provinces, Central India and the Punjab, for the purpose of connecting Standard Bench-marks at 10 Cantonment stations, and to complete the lines of levels in the Punjab partially executed last season.

DETERMINATION OF HEIGHTS BY THE HORIZONTAL BAR METHOD.

230. A system of determining the heights of points situated on steep ground by means of cross staves and a mason's level has been in force in the Levelling party for many years past; it was however considered unsatisfactory and the heights determined with it were only published to the nearest foot. During the past field season the system was revised and improved. A light wooden bar fitted with a pair of wires at each end with which to read the vertical staves, and a pair of brass slides carrying a slow motion screw to hold this bar on the staves were constructed. Experimental observations were taken with the new apparatus in the field and the results obtained were found to agree within very close limits with those of spirit levelling of precision.

This system can now be used with advantage in levelling over steep and intricate ground where the ordinary levels cannot be used.

REFRACTION OBSERVATIONS.

231. The following preliminary results were obtained—

(*a*) From mutual observations between Mussooree and Dehra Dún.
The co-efficient of refraction varied by 0·02 between 8 A.M. and 3 P.M. in both spring and autumn, but as the apparent elevations were affected proportionally to these variations there was no change in the resulting difference of height. Refraction was the same in both seasons.

(*b*) Between Mussooree and Nag Tibba.
The variation in the co-efficient of refraction between 8 A.M. and 3 P.M. was 0·005, but there was no change in the resulting difference of height.

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(*c*) Between Mussooree and Nojli.

Refraction varied considerably between 8 A.M. and 3 P.M. during each season, and also between the two seasons themselves. In the autumn the deduced difference of height varied by 70 feet and in the spring by 32 feet between 8 A.M. and 3 P.M.

232. With the aid of the refraction co-efficients obtained from the above-mentioned observations the elevations of the following snow peaks were measured throughout the recess season, Bandar Punch (20,720 ft.), Srikanta (20,120 ft.), Jaunli (21,760 ft.), Kedarnath (22,770 ft.), and Nanda Devi (25,645 ft.); if these observations can be repeated for a series of years it may be possible to deduce the varying effects of refraction and the changes in the heights of these peaks due to the increase and decrease of snow. The measurements are intended to serve as a preliminary step towards the determination of the present rate of growth of the great Himalayan range.

MAGNETIC.

No. 26 PARTY.

233. Field operations were carried out in Chota Nagpur, Orissa, the Agency tracts of the Vizagapatam district (including Bastar and Jeypore States) and Eastern Bengal and Assam, by three detachments. A fourth detachment was employed in filling up gaps in previous season's work but was withdrawn early in March to observe at repeat stations. Transport and other difficulties prevented such rapid progress as in former years, and the detachment working in Orissa suffered so much from the climate that it had to be withdrawn from field work for two months. For these reasons the total number of new stations was only 130, as compared with 206 in the previous season; the total number of stations occupied to date is 938 with 22 repeat stations.

Personnel.

Captain R. H. Thomas, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Lieutenant C. M. Browne, D.S.O., R.E., Officiating Assistant Superintendent, 1st grade, from 28th November 1905 to 26th February 1906.
Mr. E. C. J. Bond, Extra Assistant Superintendent, 6th grade.
Mr. H. P. D. Morton, Sub-Assistant Superintendent, 1st grade.
Babu R. P. Ray " " " "
Mr. E. A. Meyer " " 2nd "
Babu N. R. Mazumdar " " " "
16 Observers, etc.

234. From November to February a second Imperial officer, Lieutenant C. M. Browne, D.S.O., R.E., was posted to the party, after preliminary training he observed at four repeat stations.

235. During the recess season the computations of the field work were completed, and the tabulation and reduction of the base station results for 1905 are also practically finished. Observations for log $\pi^2 k$ have been taken with the standard and field magnets and are now under reduction. The field instruments were all compared with the standard at the beginning and end of the field season.

236. The station Declination and H. F. instruments continued to work satisfactorily throughout the year, but at Toungoo the H. F. instrument required opening up on account of interference, it was thoroughly cleaned and a new quartz suspension was mounted and the results have since been satisfactory; the experiments for determining the temperature co-efficient gave discordant results, due presumably to the system not having thoroughly settled down after the mounting of the new suspension; they will be repeated next year. The Vertical Force instrument erected at Dehra Dún has not yet given satisfactory results owing to the very high temperature coefficient; since this instrument was constructed a new pattern of compensating bar has been devised by the manufacturers in conjunction with the Kew authorities, who had experienced similar difficulties with the instruments destined for Toungoo and Kodaikanal, bars of this pattern are now being obtained for the three instruments which have arrived in India and it is hoped that the present difficulties will be overcome. The second V. F. instrument was erected in Barrackpore in July last, but defects in the driving clock necessitating prolonged repairs have caused delays, and the installation cannot be completed till November next. A third

V. F. instrument has recently been received, it is hoped that it will be possible to erect it at Kodaikanal during next field season.

237. The mean values of the magnetic elements at the observatories for 1905 are follows :—

	Declination.	H. F.	Dip.
Dehra Dún	2° 39′·9 E.	·33383 C. G. S.	43° 24′·2
Barrackpore	1° 18′·0 E.	·37242 C. G. S.	30° 22′·5
Kodaikanal	0° 31′·9 W.	·37403 C. G. S.	3° 16′·7
Toungoo	0° 48′·4 E.	·38675 C. G. S.	22° 58′·3

238. The secular changes at the base stations for the period 1904-05 deduced from the mean monthly values are as follows :—

	Changes in the year.		
	Declination.	H. F.	Dip.
Dehra Dún	— 0′·9	— 22 γ	+ 6′·7
Barrackpore	— 4′·4	+ 17 γ	+ 3′·0
Kodaikanal	+ 4·7	+ 22 γ	+ 5′·6

Pending the precise reduction of the observations at repeat stations, which will be shortly initiated, it was thought that a preliminary reduction, utilizing only approximate corrections for diurnal variation and instrumental differences, might give a reasonably close approximation to the true secular change, this was accordingly done for such repeat stations as have been established for over three seasons. In the case of declination it was found that a period of even four years was too short to give a reasonable approximation to the true secular change, this rough method not being sufficiently precise for the appreciation of the small changes involved, and this portion of the investigation was therefore abandoned ; it appears certain, however, that easterly declination is decreasing and westerly increasing over the whole of India at a very small average rate, probably about 2 to 3 minutes *per annum*, the rate of change being greater in the south of India than in the north.

In Horizontal Force the results were more promising and indicate that the annual changes are large. The following are the average changes in the districts noted, but the figures should only be regarded as preliminary approximations as in many cases the period used is only two years, and in some, especially in the south of India, the corrections for diurnal variation are at times very large :—

North-Western India and Sind	— 35 γ *per* annum.
North Central India	— 25 γ „
South Central India	— 14 γ „
Eastern India	+ 14 γ „
United Provinces of Agra and Oudh	— 26 γ „
Bengal	+ 23 γ „
Deccan and East Coast	+ 11 γ „
South India	+ 14 γ „

It thus appears that north of a line passing roughly through Dhárwár and Sambalpur Horizontal Force is decreasing, and south of it increasing. No corrections have been made to the observed results in computing the secular change in dip, but the error arising from this omission is likely to be small owing to the small diurnal range of the Vertical Force component.

The following are the average annual changes in dip that have been found :—

North-Western India and Sind	+ 6′·3	*per* annum.
North Central India	+ 6′·7	„
South Central India	+ 5′·7	„
Eastern India	+ 6′·5	„
United Provinces of Agra and Oudh	+ 5′·3	„
Bengal	+ 3′·0	„
Deccan and East Coast	+ 6′·3	„
South India	+ 7′·4	„

239. The values of declination found in India proper range from 3° 50′ E. in the extreme north at Dargai (Malakand) to 1° 5′ W. at Cape Comorin, the general trend of the true isogonals being from east to west. The line of no declination passes from the coast near Kárwár northwards to Belgaum where it turns south through Dhárwár and passing near Guntakal junction it runs south to Tumkar, from Tumkar it trends sharply northward to a point near Secunderabad whence it again turns south to near Cumbum (Southern Mahratta Railway) and then passes through a point some 40 miles south of Ongole. Isolated cases of westerly declination are met with north of this line in Lat. 19° Long. 74° near Bijapur, Bidar, and Yelgonda. The isogonals have been plotted on a chart on the scale of 80 miles to the inch, and it appears that most of the irregularities in the lines are confined to a region which is roughly indicated by the boundaries of the Deccan trap and the nearer outlying parts ; there are however some strikingly abnormal values found outside this area, of these the following are noteworthy :—

(*a*) Ongole 2° 15′ E., where the normal declination is about 0° 0′.
(*b*) Harpanahalli 1° 55′ W., the normal declination of the district being 0° 5′ W.
(*c*) Kuvoy (near Cannanore) 1° 35′ E., where one would expect about 0° 50′ W.
(*d*) Quilon 0° 10′ E., the normal declination being 1° 5′ W.
(*e*) Near Indore 0° 20′ E., „ „ „ 1° 10′ E.
(*f*) Near Pokaran (Rajputana desert) where the declination changes from 3° 5′ E., to 0° 15′ E., in 40 miles.
(*g*) Ganges valley, Buxar, 3° 35′ E., when the normal in about 1° 40′ E.
(*h*) „ „ Saran, 0° 45′ E., „ „ „ „

Of these, the values at Ongole and Harpanahalli are probably due to the known hæmatite ores of the former and the Sandur magnetites in the case of the latter.

240. Observations for determining the moment of inertia of the survey magnets have been carried out during the recess season with the inertia bars to which reference was made in last year's report. The work has proved arduous, involving the opening up of old computations for the correction of erroneous values for expansion and the investigation of the causes of the differences found in previous years. It is moreover disappointing to find that series of observations on different days with the same magnet while affording very accordant results *inter se* give discordant mean values. The observations are still in progress and until they are computed it is impossible to draw any final conclusions, although, from the evidence already collected, it seems probable that the change in Bar No. 2 as revealed by the Kew measurements of 1901 and 1905 occurred between the recess seasons of 1903-04, and further that in 1902-03 the dimensions were as originally measured and that in 1904—1906 these corresponded to the new Kew values. As regards Bar No. 17, the dimensions appear to have been the same in 1902 and 1906, but this conclusion depends only upon the results obtained from one magnet and it remains to be seen whether further experiments will confirm this view. The most satisfactory result of the experiments is that none of the field magnets appear to have lost weight, and we are therefore in a position to state what their moments of inertia were at any time. The standard magnet No. 17 does appear to have lost weight, but as this rests on the single series of experiments referred to above, it cannot be considered as finally established.

241. A table showing the approximate preliminary values (uncorrected) at the field stations for 1905-06 is appended together with a reference index chart.

242. Next year's programme provides for one detachment working in Eastern Bengal and Assam, one in the difficult country south-east of the Central Provinces, and the remaining two in Burma.

Summary of the Outturn of work of the field parties during the year 1905-06.

TOPOGRAPHICAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Triangulation.											Traverse.					Detail Survey.			
			Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Minor.			Tertiary.			Intersected points.									
							Stations fixed.	Triangular error in seconds.	Error *per* mile in feet.	Stations fixed.	Trilangular error in seconds.	Error *per* mile in feet.	Number of points fixed.	Error *per* mile in feet.	Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error *per* station in seconds.	Linear error *per mille*.	Area in square miles.	Plane table fixings *per* square mile.	Linear miles of test lines.	Number of *in situ* test fixings.
8	17	Bombay Forests	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	126	215	219·2	...
4	6	Bengal, 24-Parganas	...	...	...	...	...	...	...	...	...	...	...	...	456	478	1,612	...	...	456	...	206	...
9		Tehri Garhwal Forests	7	100·7	2·8	2·8	...	...	...	32	12	0·5	40	1·8	...	...	...	...	...	80·5	151	...	289
		Chittagong ,,	5	...	...	...	...	...	...	...	...	...	...	...	...	36·8	1,353	2·0	1·5	...	...	...	...
		Pilibhit ,,	5	...	...	...	...	...	...	...	...	...	...	...	...	64	392	0·4	1·6	17	70	...	...
		Katha ,,	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	135	2,501	5·7	4·6	317·5	166	141	...
		Mu ,,	5	...	...	...	...	...	...	...	...	...	...	...	...	125	2,026	7·7	4·2	252	171	104·5	...
		Rawalpindi ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	44·3	155	72	...
		Lahore ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9	72	15	...
		Bashahr ,,	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	..	365(*a*)	...	...	...
		Shahpur ,,	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	474(*a*)	...	...	...
		Hazara ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	24·8	166	43	...
		Betul (C. P.) ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·5	60	...	...
		Garo hills ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15·3	273	...	...
		Nowgong ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	129	...	...
	17	Bombay Forests	6	680	6·6	6·6	...	...	...	93	12	0·4	612	0·6	..	...	...	...	...	630·9	148	180·2	...
		Ganjam—Madras Forests	5 & 6	70	1·6	1·6	...	...	...	8	17	0·3	...	...	...	...	...	...	...	288·5	110		324
	19	S. and N. Malabar, Canara	...	...	...	...	...	...	...	...	...	...	...	...	...	174	3,612	5·0	2·7	194·3	153	100	177
		Godavari ,,	..	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	297·2	107	89·6	55
		Chingleput ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	51·8	78	19	55
	20	Burma, Lower Chindwin. Pakokku, Amherst Forests. Thaton districts.	...	...	..	..	...	...	...	...	...	...	..	...	...	...	...	...	...	682·2	178	380	...
		TOTAL	...	850·7	...	...	...	...	...	...	...	...	...	...	456	992·8	...	...	...	(*b*) 3,395·8	...	...	...
2	1	Central Provinces	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,320(*c*) 766(*d*)	28	219	1,676
	2	Berar	6	1,850	2·9	2·7	54	10·3	0·15	24	11·9	0·2	535	0·4	...	...	...	...	...	1,124	13·9	545	818
	6	Bengal, 24-Parganas	...	...	...	...	...	...	...	...	...	...	...	...	594	632	2,099	...	...	594	...	267	...
	9	Durrang Forests	5 & 7	345·8	34·6	34·6	...	...	...	7	12	0·3	...	...	...	230	1,942	7·0	3·3	571·3	72	106	...
	12	N.-W. Frontier	6	700	4·9	4·9	13	3·3	0·03	5	4·0	0·1	131	0·2	...	...	...	...	...	753(*e*)	24	...	...
	14	N.-W. ,,	7	2,210	3	3	...	...	...	70	7	1·4	806	(*f*)	...	...	...	...	...	736·8	28	...	533
	15	N.-W. ,,	6 & 8	2,150	(*f*)	(*f*)	(*f*)	(*f*)	(*f*)	(*f*)	(*f*)	(*f*)	(*f*)	(*f*)	...	...	...	...	...	1,741·3	34	..	633
	18	Punjab	5 & 6	...	...	...	...	...	...	...	...	...	...	...	6,350	4,497	9,889	3·0	0·2	3,047(*g*)	20	690	44
	19	Madras Forests	6	2,150	4·3	4·3	...	...	...	60	21	0·4	438	0·7	...	...	...	...	...	...	...	...	...
	20	Burma (Pakokku)	5 & 6	1,622	12	12	...	...	...	42	13	0·7	44	1·1	...	881	11,717	2·9	2·8	...	..	...	...
		TOTAL	...	11027·8	...	...	..	...	...	...	...	...	...	...	6,944	6,240	..	...	...	10,653·4	...	...	...
1	3	Lower Burma	6	3,731	10·2	10·2	15	9·3	0·07	22	5	0·08	323	0·95	...	...	...	...	...	(*h*) 3,830	7	322·5	233
	10	Upper Burma	6	2,815	5·6	5·6	32	12·4	0·11	42	6·3	0·13	420	1·02	...	410	2,055	3·4	0·7	3,340	5·7	458	1,045
	11	Shan States, Burma	6	737	7·6	8·1	...	...	...	8	5·0	0·11	89	0·27	...	...	..	...	...	2,078	6·5	...	586
		TOTAL	...	7,283	...	...	...	...	...	...	...	...	...	...	..	410	...	...	...	9,248	...	...	...

(*a*) Linear miles of boundary survey.
(*b*) Exclusive of 839 linear miles of boundary survey
(*c*) Resurvey.
(*d*) Supplementary survey.
(*e*) Includes 143 square miles of 2-inch reconnaissance and 14 square miles of 1-inch reconnaissance.
(*f*) Computations incomplete.
(*g*) Includes 330 square miles of 2-inch revision and 374 square miles of 1-inch resurvey.
(*h*) 1,594 square miles new survey, 2,096 supplementary survey, and 140 supplementary survey of forests.

Summary of the Outturn of work of the field parties during the year 1905-06.

CADASTRAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Traversing. Instrument used. Diameter in inches.	Traversing. Area in square miles.	Traversing. Linear miles of new chaining.	Traversing. Number of stations at which the theodolite was set up.	Traversing. Angular error *per* station in seconds.	Traversing. Linear error *per mille*.	Detail Survey. Area in square miles.	Detail Survey. Linear miles of test lines.	Detail Survey. Number of villages.	Detail Survey. Number of fields.	Detail Survey. Average size of fields in acres.	Record writing. Area in square miles.	Record writing. Number of villages.	Record writing. Number of fields.
16	4	Bengal, Bhágalpur	5 & 6	365 (a)	1,446	11,258	...	...	1,276 (b)	5,677	2,285	1,018,516	0·78	1,108	2,290	924,141
		„ Purnea	5 & 6	70 (c)	178	718	...	...	508	2,344	701	243,064	0·78	485	701	243,064
		„ Monghyr	5 & 6	1,492 (h)	4,685	32,535	...	...	...	...	...	...	...	...	...	...
		„ Patna	5 & 6	54	106	310	...	...	8	46	...	10,614	0·5	8	2	10,614
...	5	„ Midnapur	5 & 6	187	794	5,737	...	...	...	...	...	...	...	...	...	...
		„ Singhbum	5 & 6	573	2,147	19,477	...	...	...	...	...	...	...	...	...	...
		„ Ranchi	5 & 6	873 (d)	2,476	16,855	...	...	... (d)	...	...	...	...	...	...	...
		„ Sonthal Parganas.	5 & 6	819	2,556	17,595	...	...	22	...	...	...	...	...	...	...
...	6	E. Bengal, Dacca	5 & 6	1,638	7,240	49,444	...	...	...	...	...	...	...	...	...	...
		„ Khulna	5 & 6	106	393	2,556	...	...	...	...	...	...	...	...	...	...
...	7	Burma	5 & 6	548	1,262	11,346	0·4	0·5	1,170	1,794	564	198,498	(e) 0·89	...	...	...
		Total	...	(f) 6,725	23,283	...	...	...	(g) 2,984	...	...	...	...	1,593	...	...

(a) Includes 33 miles of traversing for topographical surveys.
(b) Includes 23 square miles of topographical survey.
(c) Includes 275 square miles of hilly ground for topographical survey.
(d) Includes 22 square miles by No. 4 Party.
(e) Calculated on the cultivated area, no survey done in jungle.
(f) Includes 330 square miles of traversing for topographical surveys.
(g) Includes 45 square miles of topographical survey.
(h) Includes Diara Survey.

SPECIAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Spirit Levelling Operations. Miles levelled over.	Spirit Levelling Operations. Permanent bench marks.	Spirit Levelling Operations. Trigonometrical stations connected with.	Traversing. Area in square miles.	Traversing. Linear miles of new chaining.	Traversing. Number of stations at which the theodolite was set up.	Detail Survey. Area in square miles.	Detail Survey. Linear miles of test lines.	Record writing. Area in square miles.	Record writing. Number of fields.
105·6	Detachment	Calcutta Suburbs	...	...	...	1	44	275	·06	6	·06	1,261
32	„	„ „	...	...	...	1			·35		·35	
16	„	Cantonment Section No. 1, Northern and Eastern Commands.	...	...	...	18	46	3,315	13	28	...	...
64	„	„ „ „	...	...	...				0·25			
16	„	Cantonment Section No. 2, Western Commands.	...	...	...	25	307	2,896	16	100	...	...
64	„	„ „ „	...	...	...				0·6			
12	„	Cantonment Section No. 3, Secunderabad Division.	...	...	...	24	209	1,901	12	40	...	...
48	„	„ „ „	...	...	...				0·32			
...	25	India (Tidal and Levelling)	388	36	5	...	...	...	...	...	...	...
		Total	388	...	...	69	597	...	42·58	...	0·41	...

Statement showing the cost-rate of work executed by the field parties during the year 1905-06.

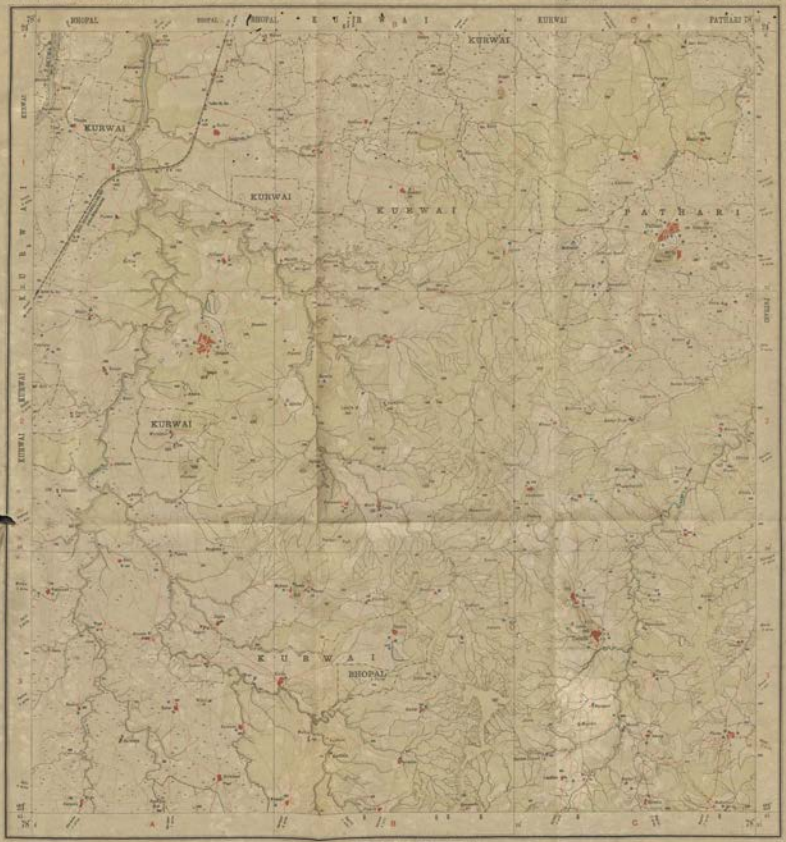
Number of Party.	Nature and *Locale* of field operations.	Cost-rate per square mile. Triangulation.	Traverse.	Detail survey and preparation of maps on scales of 1"	2"	4"	8"	16"	Stone embedding.	Completion of vernacular records, assessment statistics, etc.	Total cost of party inclusive of charges for instruments for local Governments.
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹
1	Central Provinces	...	...	...	45·6	...	...	...	...	...	88,821(*a*)
2	Berar	11·9	...	...	63·9	...	...	...	...	...	1,00,840(*b*)
3	Lower Burma	7·5	...	21·6 / 14·1(*c*)	...	...	...	...	...	.	93,843
4	Bengal (Purnea)	...	20·0	...	...	...	...	10	...	...	See below.
6	Bengal (24-Parganas Sundarbans).	...	50·4	...	36·3	43·3	...	...	...	...	"
10	Upper Burma	9·3	...	22·4 / 20·2(*c*)	...	...	...	...	...	...	1,04,133(*d*)
11	Burma (Shan States)	15·5	...	27·8	...	...	...	...	...	...	74,552(*e*)
12	North-West Frontier Province.	14·7	...	10·0(*f*)(*g*)	105·9(*g*) / 24·5(*f*)(*g*)	...	...	...	...	...	85,859
14	North-West Frontier Province.	17·7	...	...	110·7(*g*)	...	...	...	...	...	1,49,191
15	North-West Frontier Province.	35·4	...	...	85·8(*g*)	...	...	...	...	...	2,43,667
18	Punjab	...	5·8 / 9·3(*h*)	7·0 *i*)	20·2 / 10·3(*j*)	...	...	...	...	...	1,30,416
	Forest Surveys.										
9	Ráwalpindi and Lahore	...	...	...	...	37·8(*g*)	...	...	...	...	1,20,283
	Hazára	...	...	...	...	84·8(*g*)	...	...	...	...	
	Tehri Garhwal	9·3	...	...	...	35·1	...	...	...	...	
	Pilibhit	...	9·5(*k*)	...	...	17·6(*g*)	...	...	...	...	
	Chittagong, Durrang, Nowgong and Garo.	1·9	18·7(*k*)	...	30·5(*g*)	129·8	...	...	...	...	
	Katha and Mu	...	28·4(*k*)	...	...	100·3(*g*)	...	...	...	...	
17	Bombay	13·2	...	...	...	87·4	173·2	...	...	...	82,630
19	Madras	33 (*l*) / 6·0(*m*)	28·1	...	...	104·1	...	...	...	...	1,06,926
20	Burma	9·1	42·6(*k*)	...	...	147·7	...	...	...	...	1,52,254
	Cadastral Surveys.										
4	Bhágalpur	...	44·7	...	...	...	...	76·1	...	58·6	3,17,522(*n*)
	Purnea	...	33·8	...	...	...	...	73·5	...	45·7	
	Monghyr	...	31·2	...	...	...	...	...	...	...	
5	Midnapur	...	31·5	...	...	...	...	...	...	...	96,278(*o*)
	Singhbum	...	35·1	...	...	...	...	...	...	...	
	Ranchi	...	34·4	...	...	...	...	...	...	...	
	Sonthal-Parganas	...	33·8	...	...	...	...	...	...	...	
6	Dacca	...	41·2	...	...	...	...	...	...	...	1,99,975(*p*)
	Khulna	...	44·7	...	...	...	...	...	...	...	
7	Burma (Pakkoku)	...	75·0	...	...	...	...	95·5(*q*)	16·0	...	1,82,029(*r*)
Detachment.	Cantonment Section No. 1, Northern and Eastern Commands.	...	6·3(*s*)(*g*)	...	...	...	...	1·3(*s*)(*g*)	...	...	18,860(*t*)

(*a*) Includes ₹3,079 for triangulation charts, ₹4,844 for traversing village boundaries for the Settlement department, ₹14,955 for fair mapping.
(*b*) Includes ₹1,606 for traversing forest boundaries for the Forest Department.
(*c*) Supplementary survey.
(*d*) Includes ₹5,298 for traversing for which no area can be given.
(*e*) Includes ₹9,193 expended on the instruction of surveyors.
(*f*) Reconnaissance.
(*g*) Exclusive of mapping.
(*h*) Riverain traverse.
(*i*) Resurvey.
(*j*) Revision survey.
(*k*) Cost per linear mile.
(*l*) For 4-inch survey.
(*m*) For 2-inch survey.
(*n*) Includes ₹41,966 for miscellaneous surveys.
(*o*) Includes ₹6,536 for miscellaneous surveys.
(*p*) Includes ₹94,307 for topographical and ₹16,326 for miscellaneous surveys.
(*q*) Does not include cost of preparation of standard maps and charts.
(*r*) Includes ₹1,663 for the completion of records of Rangoon town, ₹4,738 for traverse charts, and ₹3,606 for fair mapping.
(*s*) Cost per acre and includes 64-inch survey.
(*t*) Includes ₹3,960 for mapping.

Statement showing cost of Scientific Parties for the survey year 1905-06.

Number of Party.	Name of Party.	Nature of Scientific Work.								Total cost of Party.
		Astronomical determinations.	Principal Triangulation.	Determinations of Gravity.	Tidal observations.	Preparation of Tide tables.	Levelling operations.	Magnetic observatories.	Magnetic Field work.	
		₹	₹	₹	₹	₹	₹	₹	₹	₹
22	Astronomical	5,507	...	...	...	...	...	...	...	5,507
23	Pendulums	...	...	31,844	...	...	...	...	...	31,844
24	Triangulation	...	52,028	..	...	...	...	...	...	52,028
25	Tidal and Levelling	...	...	...	11,817	24,374	40,103	...	...	76,294
26	Magnetic	...	...	...	...	...	...	11,408	54,355	65,763
	TOTAL	5,507	52,028	31,844	11,817	24,374	40,103	11,408	54,355	2,31,436

PARTS OF GWALIOR & BHOPAL STATES. Season 1905-06. **CENTRAL INDIA & RAJPUTANA** Magnetic Variation 1° 30' East (1905.) (Preliminary Edition). No. 55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APPENDIX.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1905-06.

Serial No.	Name of station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	°	C.G.S.	
809	Diamond Harbour.	22/88 5	22 11 20	88 11 40	29 12	E 1 12	0·3744	
810	Canning	,, 6	22 18 20	88 39 50	29 35	,, 1 10	0·3742	
811	Bangaon	23/88 7	23 1 50	88 50 20	30 57	,, 1 11	0·3728	
812	Jessore	23/89 1	23 9 50	89 12 40	31 15	,, 1 12	0·3717	
813	Khulna	22/89 1	22 49 0	89 33 20	30 40	,, 1 11	0·3727	
814	Barisál	,, 2	22 41 10	90 22 0	30 17	,, 1 5	0·3743	
815	Morelganj	,, 3	22 27 10	89 51 50	29 55	,, 1 3	0·3751	
816	Chandpur	24/90 2	23 14 0	90 38 0	31 29	,, 1 10	0·3731	
817	Madáripur	,, 3	23 10 50	90 12 30	31 21	,, 1 10	0·3731	
818	Dolaigaonj	,, 4	23 42 10	90 25 30	32 26	,, 1 11	0·3708	
819	Sripur	,, 5	24 12 50	90 29 0	33 16	,, 1 19	0·3697	
820	Mymensingh	,, 6	24 46 0	90 23 40	34 27	,, 1 29	0·3670	
821	Jagannathganj	,, 7	24 41 10	89 45 50	34 18	,, 1 2	0·3684	
822	Porabari	,, 8	24 13 20	89 51 30	33 24	,, 1 24	0·3688	
823	Faridpur	,, 9	23 37 10	89 51 10	33 8	,, 1 17	0·3710	
824	Kumarkhali	,, 10	23 51 50	89 14 0	32 33	,, 1 17	0·3692	
825	Chuadanga	23/88 8	23 38 40	88 51 40	32 13	,, 1 17	0·3700	
826	Krishnagar	,, 9	23 22 40	88 29 10	31 44	,, 1 24	0·3704	
827	Plassey	,, 10	23 46 20	88 17 10	32 5	,, 0 53	0·3718	
828	Nawabganj	,, 11	24 35 40	88 16 0	34 8	,, 1 39	0·3665	
829	Bulbulchundee	,, 12	24 58 50	88 14 30	35 0	,, 1 29	0·3636	
830	Malanchi	,, 13	24 18 40	88 57 50	33 46	,, 1 3	0·3696	
831	Santahar	,, 14	24 48 10	88 59 20	34 16	,, 1 30	0·3671	
832	Fulchhari	25/90 1	25 11 40	89 37 0	35 12	,, 1 26	0·3646	
833	Kaunia	,, 2	25 47 10	89 25 0	36 28	,, 1 35	0·3621	
834	Cooch Behar	,, 3	26 18 30	89 26 20	37 16	,, 1 43	0·3608	
835	Jainti	,, 5	26 41 20	89 36 30	38 23	,, 2 15	0·3521	
836	Parbatipur	25/88 3	25 39 10	88 55 10	36 7	,, 1 32	0·3631	
837	Panchabibi	25/89 4	25 11 30	89 1 40	35 12	,, 1 37	0·3644	
838	Chilahati	26/88 5	26 14 30	88 48 10	37 0	,, 1 41	0·3601	
839	Siliguri	,, 6	26 42 20	88 26 10	37 55	,, 1 55	0·3572	
840	Radhikapur	,, 7	25 38 30	88 26 50	36 10	,, 1 28	0·3629	
841	Barsoe	,, 8	25 38 50	87 55 40	36 12	,, 1 34	0·3614	
842	Kishanganj	,, 9	26 5 50	87 56 50	36 37	,, 1 35	0·3615	
843	Purnea	25/87 4	25 46 30	87 31 10	36 25	,, 1 20	0·3621	
844	Madhipura	25/86 6	25 55 40	86 47 30	36 29	,, 1 29	0·3611	
845	Banarhat	26/89 6	26 47 30	89 1 20	38 16	,, 1 40	0·3572	
846	Dhubri Ghat	,, 7	26 1 0	89 59 50	36 31	,, 1 21	0·3636	
847	Goálpárá	,, 8	26 11 10	90 37 40	36 47	,, 1 41	0·3617	
848	Kholabhanda	26/92 1	26 10 0	91 8 20	36 57	,, 1 35	0·3615	
849	Palásbári	,, 2	26 7 40	91 32 40	36 57	,, 1 33	0·3622	
850	Mangaldai or Karupatia Ghat.	,, 3	26 28 50	92 8 20	37 34	,, 1 43	0·3617	
851	Tezpur	,, 4	26 37 50	92 48 20	38 46	,, 1 11	0·3611	
852	Behali Mukh	26/93 1	26 46 20	93 21 50	38 11	,, 1 37	0·3598	
853	Kokila Mukh	,, 2	26 51 10	94 8 50	38 22	,, 1 30	0·3603	
854	Názirá	,, 3	26 54 30	94 43 50	38 30	,, 1 19	0·3601	
855	Sapekhati	27/95 1	27 6 40	95 9 40	38 53	,, 1 26	0·3599	
856	Márgherita	,, 2	27 17 20	95 41 20	39 5	,, 1 18	0·3594	
857	Táláp	,, 3	27 40 10	95 33 40	39 53	,, 1 29	0·3577	
858	Oating	26/94 4	26 26 10	93 59 30	37 55	,, 1 46	0·3600	
859	Manipur Road (Dimápur).	,, 5	25 54 50	93 43 50	36 42	,, 1 13	0·3649	
860	Lunding	,, 6	25 44 50	93 10 40	36 12	,, 1 26	0·3666	
861	Kámpur	26/93 5	26 9 40	92 39 30	36 49	,, 1 27	0·3626	
862	Jági Road (Nakholá).	,, 6	26 7 20	92 11 30	37 6	,, 1 36	0·3646	
863	Shillong	,, 7	25 35 0	91 53 40	35 38	,, 1 21	0·3654	
864	Shangpung	,, 8	25 28 50	92 21 0	35 54	,, 1 40	0·3642	
865	Korongmæ	,, 9	25 26 10	92 43 30	35 54	,, 1 18	0·3660	
866	Háflang	25/93 7	25 11 30	93 1 10	35 14	,, 1 33	0·3629	
867	Karimganj	24/92 1	24 52 0	92 22 10	34 37	,, 1 25	0·3683	
868	Tilágáon	,, 2	24 26 40	91 57 30	33 49	,, 1 20	0·3697	
869	Sáistáganj	,, 3	24 16 50	91 26 10	33 30	,, 1 15	0·3700	
870	Kamalasagar	,, 4	23 44 40	91 9 10	32 26	,, 1 17	0·3720	
871	Laksam	,, 5	23 15 40	91 7 20	31 30	,, 1 12	0·3735	
872	Noakhali	22/91 1	22 48 20	91 6 30	30 36	,, 1 6	0·3748	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1905-06—contd.

Serial No.	Name of station.	Survey No.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ° ′	Declination. ° ′	Horizontal Force. C.G.S.	Remarks.
873	Jamtara	7	23 58 40	86 48 50	32 59	E 1 23	0·3662	
874	Dumka	14	24 15 50	87 14 40	33 17	„ 1 33	0·3664	
875	Godda	„ 15	24 50 20	87 12 30	34 40	„ 1 8	0·3615	
876	Deoghur	8	24 29 0	86 41 0	33 45	„ 1 25	0·3658	
877	Ganwan	„ 9	24 37 10	85 55 20	34 1	„ 1 42	0·3645	
878	Bagodar	„ 10	24 4 50	85 49 30	33 5	„ 1 20	0·3658	
879	Hazaribagh	„ 11	23 59 40	85 22 10	32 38	„ 1 16	0·3682	
880	Chorparan	„ 12	24 22 30	85 15 40	33 33	„ 1 17	0·3645	
881	Emaumgunj	4	24 27 20	84 34 50	33 27	„ 1 14	0·3651	
882	Chatra	„ 5	24 12 10	84 53 0	32 51	„ 1 26	0·3647	
883	Balumath	„ 6	23 50 10	84 47 40	32 21	„ 1 17	0·3710	
884	Lohardaga	„ 7	23 25 30	84 41 10	31 27	„ 1 15	0·3677	
885	Latehar	„ 8	23 45 10	84 29 50	32 16	„ 1 21	0·3698	Re-observed.
886	Daltonganj	„ 3	24 2 10	84 3 40	32 38	„ 1 20	0·3662	
886	Meeral	„ 9	24 11 20	83 42 30	32 56	„ 1 20	0·3671	
887	Dúdhi	„ 10	24 12 40	83 14 30	33 8	„ 1 31	0·3647	
888	Manchee	„ 11	24 39 40	83 25 50	34 10	„ 1 50	0·3617	
889	Sháhganj	10	24 42 30	82 56 40	34 5	„ 1 20	0·3613	
890	Lalganj	11	25 1 20	82 22 10	34 36	„ 1 32	0·3604	
891	Mauganj	2	24 40 50	81 50 40	34 11	„ 1 37	0·3598	
892	Sohagi	„ 3	24 59 20	81 42 0	34 37	„ 1 21	0·3601	
893	Rewah	„ 4	24 33 0	81 17 50	33 50	„ 1 22	0·3611	
894	Rámnagar	„ 5	24 11 0	81 8 50	33 17	„ 1 26	0·3614	
895	Majhuli	„ 6	24 6 50	81 37 0	33 12	„ 1 7	0·3652	
896	Jiawan	„ 7	24 20 20	82 16 20	33 29	„ 1 24	0·3683	
897	Saipur	„ 8	24 2 30	82 41 30	32 44	„ 1 21	0·3653	
898	Goini	„ 9	23 48 0	82 19 20	32 0	„ 1 23	0·3673	
899	Bharatpur	„ 11	23 44 10	81 46 10	32 21	„ 1 14	0·3638	
900	Ninguani	„ 12	23 18 50	82 0 30	31 16	„ 1 17	0·3651	
901	Baikunthpur	„ 13	23 16 20	82 33 0	31 7	„ 1 12	0·3674	
902	Mátin	12	22 43 50	82 25 0	30 32	„ 1 14	0·3685	
903	Korba	„ 13	22 20 30	82 42 30	29 40	„ 0 59	0·3701	
904	Dharamjaygarh	5	22 28 10	83 13 20	29 50	„ 1 6	0·3693	
905	Sikirma	„ 6	22 26 40	83 56 20	29 45	„ 1 4	0·3682	
906	Jashpur	„ 7	22 52 40	84 8 30	30 43	„ 1 7	0·3694	
907	Champa	12	23 13 0	83 45 10	31 11	„ 1 19	0·3673	
908	Kalnai	8	22 46 30	83 30 20	30 24	„ 1 11	0·3701	
909	Bisrampur	13	23 6 30	83 12 10	30 59	„ 1 13	0·3659	
910	Kunra	13	25 22 30	71 2 40	35 1	„ 1 53	0·3489	
911	Khésar	14	25 21 50	70 28 40	34 39	„ 1 37	0·3475	
912	Mithrea	„ 15	25 9 40	70 0 0	35 11	„ 1 39	0·3449	
913	Piareh Koláchi	„ 16	25 1 30	69 26 20	34 32	„ 2 6	0·3471	
914	Talhár	6	24 53 0	68 49 0	34 4	„ 1 43	0·3477	
915	Mirpur Batoro	„ 7	24 44 10	68 15 20	33 52	„ 1 37	0·3476	
916	Sháhbandar	„ 8	24 10 0	67 54 0	32 47	„ 1 33	0·3494	
917	Mirpur Sákro	„ 9	24 33 10	67 37 0	33 33	„ 1 37	0·3476	
918	Mandvi (Cutch)	8	22 49 30	69 22 0	30 20	„ 1 46	0·3547	
919	Jakhau	10	23 13 10	68 43 10	30 53	„ 1 31	0·3534	
920	Banri	11	23 44 50	69 29 40	32 25	„ 1 40	0·3502	
921	Trangeri Bet	„ 12	23 51 20	70 4 20	32 43	„ 0 57	0·3511	
922	Lodhráni	„ 13	23 53 50	70 37 30	32 10	„ 1 30	0·3538	
923	Suigám	15	24 9 10	71 21 10	32 42	„ 1 4	0·3562	
924	Kalavád	10	22 12 20	70 22 50	29 37	„ 0 55	0·3577	
925	Salaya	„ 9	22 18 10	69 36 20	30 1	„ 1 38	0·3582	
926	Dwárka	1	22 14 40	68 57 10	29 39	„ 1 41	0·3562	
927	Gigásarán	11	21 17 0	70 57 10	27 25	„ 0 50	0·3623	
928	Ghoba	11	21 25 40	71 34 20	27 47	„ 0 41	0·3608	
929	Sendwa	14	21 40 50	75 5 20	28 31	„ 0 47	0·3670	
930	Bori	14	22 8 10	77 25 10	28 23	„ 1 9	0·3632	
931	Dhár	„ 15	22 21 20	77 51 20	29 22	„ 1 4	0·3666	
932	Jámundonga	„ 16	22 23 0	78 31 30	29 39	„ 1 0	0·3660	
933	Jangawáni	12	22 23 30	79 9 20	29 32	„ 1 13	0·3694	
934	Hospet	2	15 16 50	76 23 0	14 31	W 0 4	0·3797	
935	Rassul	6	20 37 20	85 19 10	26 5	E 1 4	0·3780	
936	Hondapa	2	20 56 30	84 12 10	26 42	„ 0 57	0·3762	
937	Charmal	9	21 6 20	84 12 50	27 7	„ 0 53	0·3749	
938	Sonpur	3	20 50 40	83 54 30	26 25	„ 0 46	0·3759	
939	Bisipara	„ 4	20 24 50	84 12 30	25 33	„ 0 48	0·3764	
940	Mojjagada	„ 5	20 1 10	84 31 0	24 50	„ 0 43	0·3779	
941	Dashpala	„ 6	20 18 40	84 54 0	25 28	„ 0 49	0·3774	
942	Sihawa	4	20 18 40	81 54 40	25 47	„ 0 54	0·3729	
943	Raigarh	„ 5	19 53 20	82 4 20	24 50	„ 0 53	0·3755	
944	Dabgaon	6	19 27 0	82 24 40	23 48	„ 0 31	0·3758	
945	Jeypore	4	18 51 30	82 34 40	22 37	„ 0 29	0·3767	
946	Padva	„ 5	18 22 20	82 40 40	21 29	„ 0 18	0·3800	
947	Raivalsa	4	18 13 50	83 1 30	21 3	„ 0 41	0·3794	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1905-06—concld.

Serial No.	Name of station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
948	Bobbili	14 5	18 34 30	83 21 10	21 59	E 0 27	0·3794	
949	Rayagadda	14 7	19 9 50	83 24 40	23 6	„ 0 25	0·3778	
950	Tikarapara	„ 8	19 37 40	83 29 20	24 2	„ 0 35	0·3770	
951	Dadpur	14 9	19 58 40	83 13 40	24 45	„ 0 29	0·3761	
952	Junagarh	14 7	19 51 50	82 56 10	24 36	„ 0 23	0·3765	
953	Jamgaon or Jaipatna.	„ 8	19 28 10	82 48 20	23 45	„ 0 26	0·3769	
954	Jagdalpur	14 9	19 5 40	82 1 40	22 51	„ 0 38	0·3766	
955	Bhakawada	14 6	18 44 30	81 48 30	22 30	„ 0 28	0·3767	
956	Govindpilli	„ 7	18 34 50	82 17 0	21 55	„ 0 31	0·3799	
957	Malkangiri	„ 8	18 21 50	81 53 30	21 33	„ 0 24	0·3802	
958	Pusigudiam	„ 9	17 53 0	81 31 10	20 16	„ 0 25	0·3804	

Repeat Stations.

I	Udaipur	24 35 33	73 41 57	33 37	E 1 26	0·3532	
II	Karachi	24 49 50	67 2 2	33 58	„ 1 41	0·3403	
III	Quetta	30 11 52	67 0 20	42 54	„ 3 0	0·3238	
IV	Bahawalpur	29 23 27	71 40 37	42 56	„ 2 53	0·3324	
V	Rawalpindi	33 35 16	73 3 6	48 4	„ 3 43	0·3129	
VI	Bharatpur	27 43 31	77 29 28	38 35	„ 2 2	0·3464	
VII	Bangalore	12 59 35	77 35 58	9 39	W 0 30	0·3814	
VIII	Dharwar	15 27 26	74 59 35	15 10	„ 0 6	0·3763	
IX	Porbandar	21 38 20	69 37 6	28 32	E 1 16	0·3606	
X	Fyzabad	26 47 27	82 7 40	37 47	„ 1 52	0·3534	
XI	Sambalpur	21 28 3	83 58 26	27 43	„ 0 58	0·3726	
XII	Waltair	17 42 54	83 19 8	20 21	„ 0 23	0·3782	
XIII	Darjeeling	26 59 49	88 16 39	38 14	„ 1 45	0·3567	
XIV	Gaya	24 46 30	84 58 54	34 9	„ 1 16	0·3663	
XV	Secunderabad	17 27 21	78 29 16	20 0	„ 0 23	0·3791	
XVI	Bhusaval	21 2 46	75 47 18	26 49	„ 0 56	0·3682	
XVII	Jubbulpore	23 8 57	79 56 44	30 52	„ 1 8	0·3643	
XVIII	Tavoy	14 4 50	98 12 30	12 17	„ 0 42	0·3947	
XIX	Lashio	22 56 47	97 44 40	31 16	„ 0 54	0·3759	
XX	Akyab	20 7 53	92 53 18	25 26	„ 0 49	0·3829	
XXI	Silchar or Cachar.	24 49 43	92 47 21	34 37	„ 1 22	0·3688	
XXII	Dibrugarh	27 29 24	94 55 40	39 25	„ 1 27	0·3584	

NOTE—The above values of Dip, Declination, and Horizontal Force are uncorrected for secular change, diurnal variation, instrumental differences, etc., and are to be considered as preliminary values only.

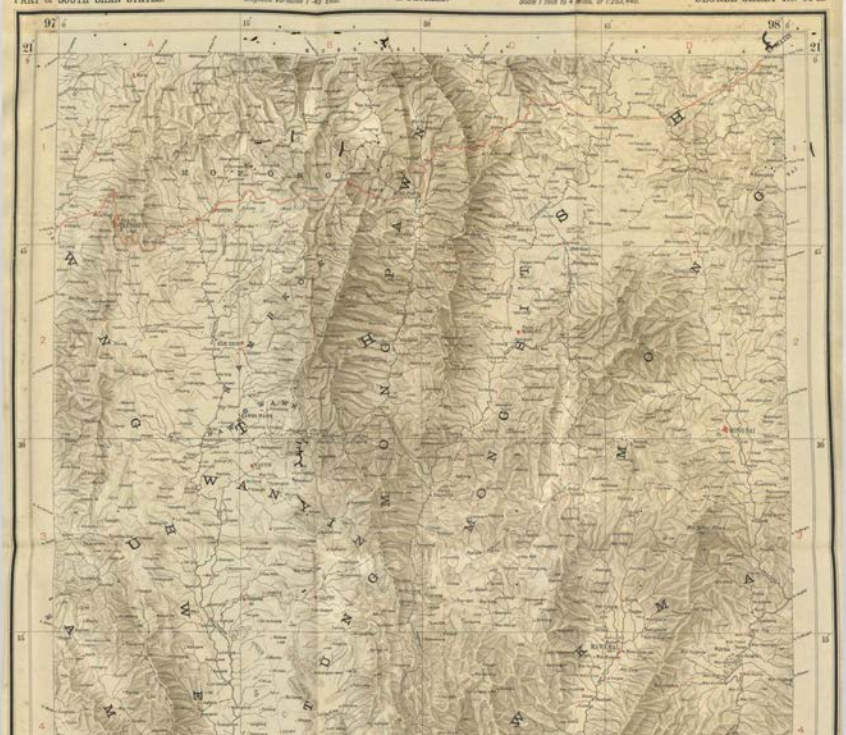
Where blanks occur, values have been already found during previous field seasons, or the observations have not been completed.

The survey numbers refer to the published chart: thus No. 14 3 denotes No. 3 station in the dotted square, the spherical co-ordinates of whose centre are 26° North Latitude, and 76° East Longitude.

All Longitudes are referrible to that of Madras observatory taken at the value 80° 14′ 47″ East from Greenwich.

G. I. C. P. O.—No. 117 S. G.—12-12-07—450—A. D'C.

PART of SOUTH SHAN STATES. Magnetic Variation 1° 45' East. BURMA. Scale 1 inch to 4 Miles, or 1:253,440. DEGREE SHEET No. 93 H.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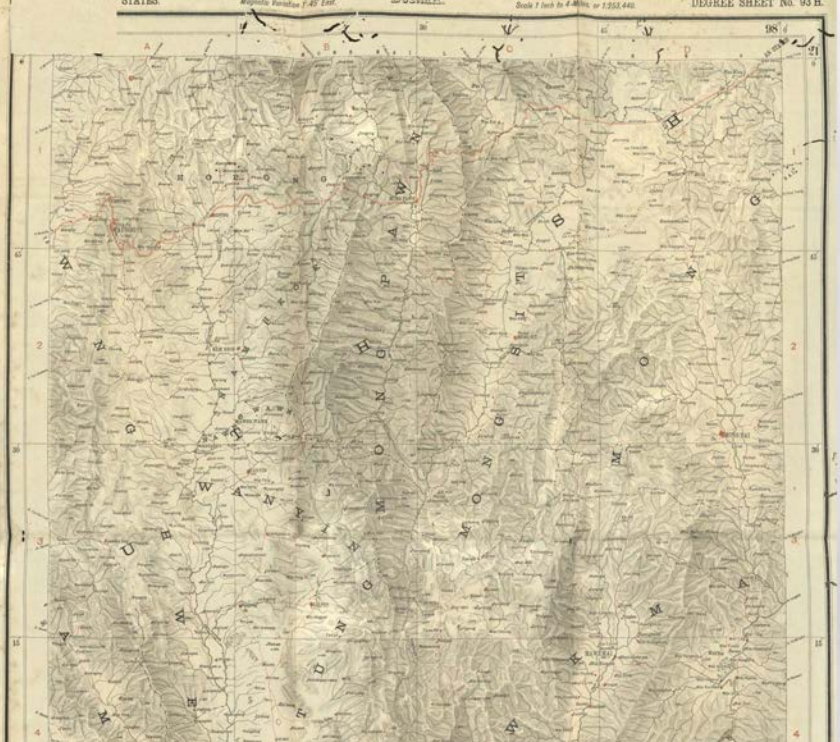
STATES. Magnetic Variation 1° 45' East. BURMA. Scale 1 Inch to 4 Miles, or 1:253,440. DEGREE SHEET No. 93 H.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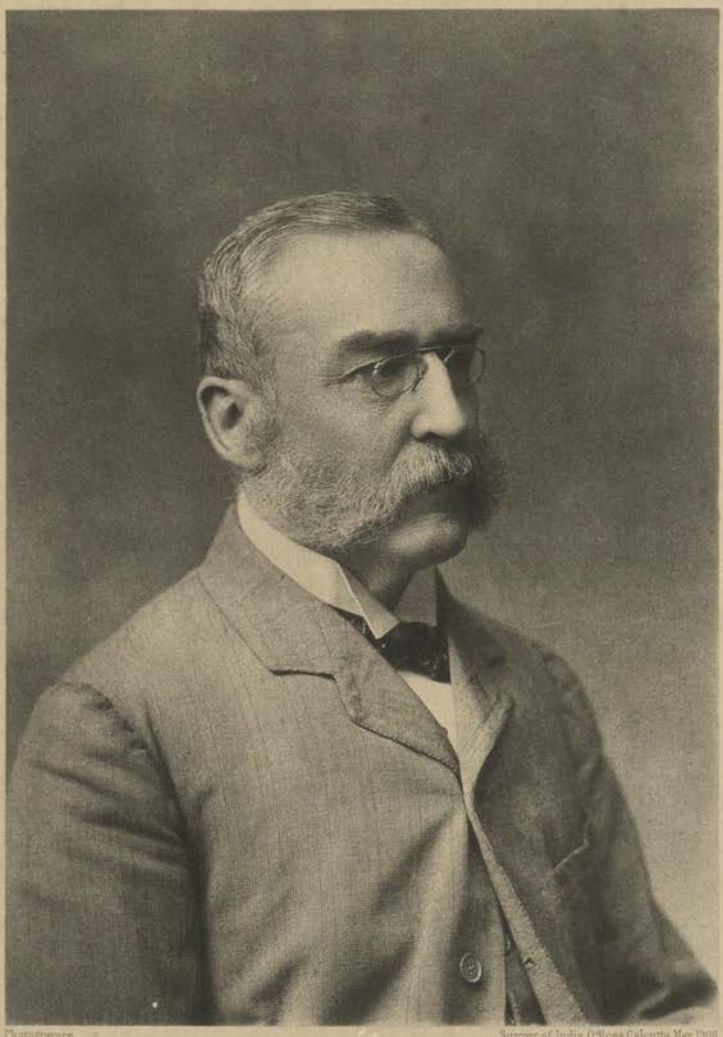

Photogravure. Survey of India Offices, Calcutta, May 1906.

MAJOR-GENERAL JAMES WATERHOUSE, I.A.

ASSISTANT SURVEYOR-GENERAL

IN CHARGE OF THE PHOTOGRAPHIC AND LITHOGRAPHIC OFFICES OF THE SURVEY OF INDIA

From April 1876 to June 1907

Printed from a negative supplied by Mr. H. Cooper, Sub Asst. Supdt., S. I. D.

Survey of India Offices, Calcutta, 1909.

GROUP OUTSIDE A "SUMMER HUT" ON THE TOBA-CHAMAN.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1906-07

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E.

SURVEYOR GENERAL OF INDIA

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1908

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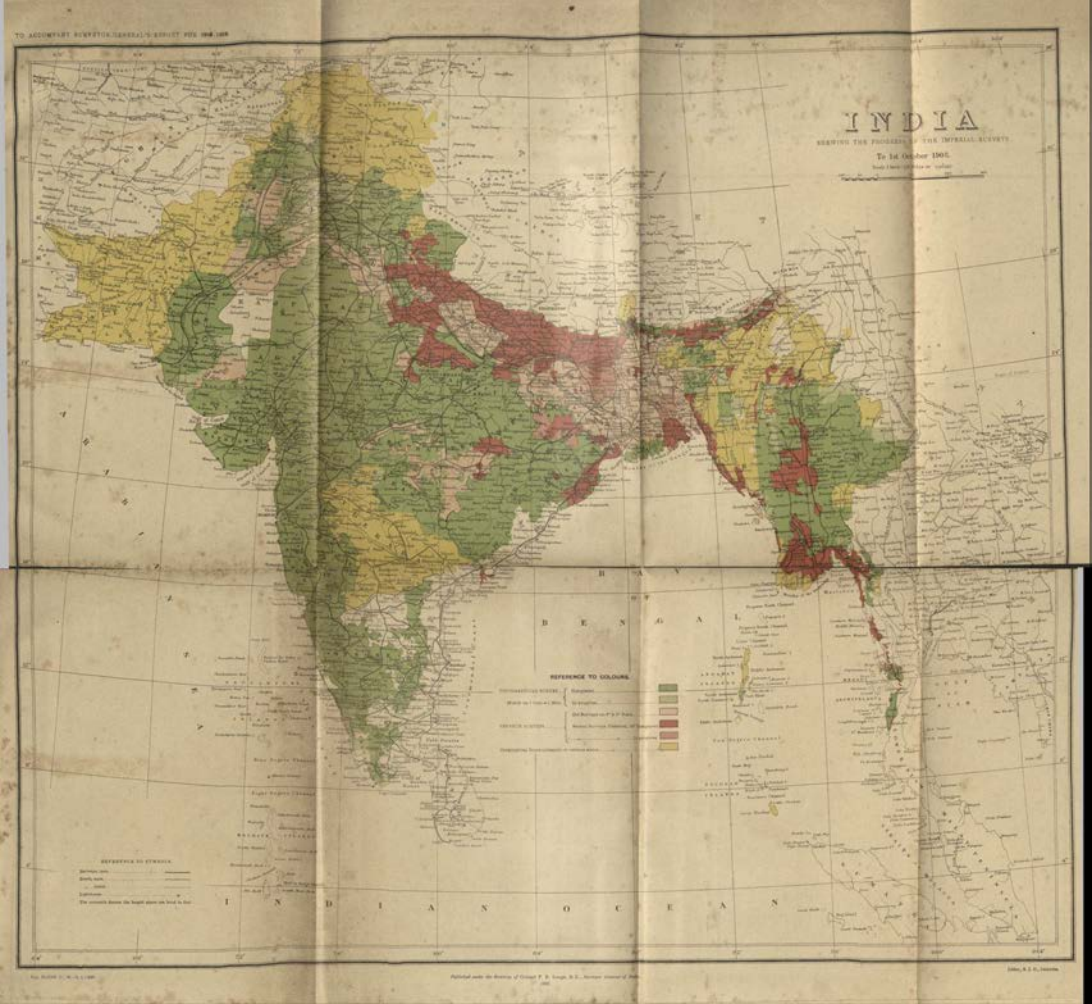
BAY OF BENGAL
INDEX CHART
OF THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA


INDIA
To 1st October 1906.
REFERENCE TO COLOURS
BENGAL
INDIAN OCEAN

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1906-1907.

PART I.

SUMMARY.

ADMINISTRATION.

1. This report deals with the operations of the department for the year ending the 30th September 1907.

Colonel F. B. Longe, R.E., administered the department throughout the year.

Colonel G. B. Hodgson, I.A., continued to hold his appointment of Deputy Surveyor General; Colonel S. G. Burrard, F.R.S., R.E., Superintendent, Trigonometrical Surveys, remained in charge of that branch until he proceeded on combined leave on the 19th March when Mr. J. Eccles, M.A., was appointed to officiate for him.

Lieutenant-Colonel P. J. Gordon, I.A., on the abolition of his appointment of Superintendent, Forest Surveys, in October, was nominated Superintendent in charge of Burma Surveys; Major C. H. D. Ryder, D.S.O., R.E., continued to hold the appointment of Superintendent, Northern Circle, throughout the year.

Major R. T. Crichton, I.A., was Superintendent, Provincial Surveys, Bengal, until 28th March when he proceeded on combined leave and was succeeded by Captain F. C. Hirst, I.A.

2. The publication of last year's report was delayed owing to discussions regarding the classification of maps, and it was only published in December 1907.

3. A scheme has been submitted to the Government of India for the re-organisation of the Photo-Lithographic offices and all the offices connected with mapping, map printing and issue have been combined under the superintendence of Major Hedley, R.E., with Major J. M. Burn, R.E., and Major Coldstream, R.E., in charge of the Drawing-Engraving and Photo-Lithographic offices, respectively.

The Punjab parties were all concentrated at Mussooree during the summer recess and those of the Burma Circle at Bangalore.

4. Beyond this no further progress was made in the re-organisation of the department as the final scheme is still under discussion.

5. Further discussions regarding the symbols to be used for different classes of roads and the insertion of boundaries have seriously hampered the preparation of the standard sheets and general maps of India and the 32-mile map of India and adjacent countries is still unpublished, but everything is practically now settled on these points and the large number of maps which have accumulated will be printed off during the coming year.

6. Slight modifications have been made in the footnotes and tables of symbols on maps on the 1-mile scale and a specimen in what is hoped will be the accepted style is attached to this report.

7. The scale on which the field surveys should be executed and the larger scale standard maps published was under discussion towards the end of the

134669

year, this point having been raised by the Army Council and it has been decided that the general scale of survey shall be 1 inch = 1 mile, but that reserved forests and special areas shall be surveyed on the scale of 2 inches = 1 mile if required and that even the scale of 1 inch = 2 miles shall be employed for desert tracts and in sparsely populated hill country. It is probable, however, that such tracts will be avoided until the more important areas have been completed and a better estimate can be formed of their probable importance in the future. It would seem a doubtful policy to survey any areas now on a scale which is not nearly certain to fulfil all practical requirements for the next 20 years.

It has further been decided that the general scale of publication for this series shall be 1 inch = 1 mile.

8. Last year the progress of topographical work was shown for each party by means of $\frac{1}{\text{million}}$ sheet index maps. These proved likely to become too numerous owing to the scattered nature of the work and to be unnecessarily cumbersome; in this year's report 3 index maps have been substituted covering the whole of India, Assam and Burma which show the progress irrespective of parties, a reference after the name of the party showing the index on which its progress will be found. Similar index maps are published to show the progress of publication. These latter show by different colours the maps which have been published in previous years from surveys made prior to 1880, those published from surveys made between 1881 and 1904 and those published from later surveys; they also show in the same manner those published during the year for each of the 3 classes, and it is hoped these will prove satisfactory.

9. The department has been materially increased during the last few years in Imperial and Provincial officers, and the class of work has improved owing to their supervision and the time they have been able to devote to instructing the field surveyors and draftsmen; and this is especially noticeable in the vast improvement in drawing over that of later years. The present aim is to have efficient supervision and an improved class of workman, and, if anything, to reduce the number of surveyors for a given area, but to increase the outturn by employing only really efficient men. The pay of surveyors has always been small and in many instances quite out of proportion to the expenses they put the department to owing to their camp followers and frequent incapacity, but with increased supervision and consequently powers of instruction the bad men will be weeded out and the competent men will be capable of turning out a much larger area than before.

10. Major General J. Waterhouse, late I. S. C., whose portrait is given as the frontispiece of this volume, served for 31 years in this department, and for almost the whole of this time he was in charge of the map printing offices. At a time when the style of our maps and methods of map publication are being changed, it may not be considered out of place to record in this manner the valuable services of this distinguished officer, of whom Major-General Strahan (then Surveyor General) says in the General Report for 1896-97: "The "immense development and the great success of the various methods of repro- "ducing maps and half-tone subjects now in use are entirely due to Colonel "Waterhouse and his retirement is a serious loss to the department." Since his retirement in 1897 General Waterhouse has maintained his deep interest in the welfare of the department, and has frequently given it the benefit of his wide experience and great technical knowledge. He has selected for it specialists in the various photo-lithographic trades in a way that no other officer could have done, for he alone knew the particulars and details of the work to be executed in this country, and in 1904 he wrote a valuable description of the United States survey methods for the use of the Survey of India at the request of the Secretary of State for India. This report was published in 1906 by order of the Government of India. The portrait will interest the younger and future members of the department, and recall to those who served with him the invariable kindness and courtesy they experienced at his hands.

Inspection Tours of Administrative Officers.

11. Colonel F. B. Longe, R.E., Surveyor General, inspected the office of No. 18 Party at Simla on the 9th October 1906, and during his return from

Simla in the beginning of November he visited Agra, Gwalior and Cawnpore, arriving at Calcutta on the 10th November. On the 1st February he left for Burma where after discussing the future conduct of survey operations in that province with the local government he inspected the field work of No. 10 Party. From Burma he proceeded *viâ* Colombo to Bangalore where he inspected the office of the Superintendent in charge of Burma Surveys and the Bangalore Drawing office, and also visited the head-quarters office of No. 19 Party. From there he proceeded to Satara with the object of testing its suitability as a circle head-quarters. Thence he went to Nasik with a view to investigate the suitability of the place for the head-quarters offices of the department, and returned to Calcutta on the 26th March. On the 5th April he left Calcutta and arrived at Simla on the 7th idem. On the 1st July he proceeded to Dehra and Mussooree. He returned to Simla on the 20th July.

At Mussooree he presided over the conference of the administrative officers, at which the main points that were discussed and settled were the method of depicting the various topographical items on the new one-inch standard sheet series, the symbols to be used on them, the thickening of contours at certain intervals and the insertion of contour values in the body and margins of the maps. Then came the rules for the guidance of surveyors in the field, and lastly, the orders regarding the drawing of the fair sheets in recess, their examination, and the responsibilities of the various officers concerned in their preparation. On all these points tentative orders have been already issued in the form of Circular Orders (Professional) or Circular Memoranda, but experience showed that these orders were not all practicable, and that some of them required considerable modification. In order to ensure uniformity and to prevent confusion, a small pamphlet has been prepared embodying all the conclusions arrived at, and this is intended to supersede all previous instructions on the points touched on and will be strictly adhered to in future. One of the main changes is that the officer in charge of the party will be held responsible for the completeness and accuracy of his maps when they are submitted for publication, and he will have no opportunity of applying corrections to them in proof form. The printing office will be responsible for their correct reproduction.

The next point discussed was the present system by which each topographical party did its own triangulation and traversing, and whether it would not be better to hand over all such work to the Trigonometrical branch. The conclusion arrived at practically unanimously was, that the present system was unsatisfactory mainly because the work was often conducted on unscientific principles, and generally with the sole object of providing points for the plane-table surveyors, that it interfered seriously with the topographical outturn, and being performed under so many different executive and administrative officers it was never harmonised, and when the work of two parties met it was frequently found that there were discrepancies in heights and other details which would have been avoided had the work been carried out systematically under one administrative officer and by thoroughly trained assistants. It was therefore decided that though the present system must continue temporarily, a scheme should be drawn up to strengthen the Trigonometrical at the expense of the Topographical branch and to form a triangulation and levelling party for each circle, of sufficient strength to carry out all the necessary triangulation on far more rigorous methods, and in place of the present tertiary triangulation to substitute plane-table triangulation, by which means all the necessary supplementary points would be provided for the topographical surveyor, much in the same way as the framework of surveys is prepared in America. This scheme will be worked out, if possible, during the cold weather.

This proposed change of system will not necessitate any increase of establishment, but it will give a vastly greater importance to the Trigonometrical branch, and in every way tend to efficiency and raise the standard of our work.

The next point discussed was the question of charts, and it was decided that intersected points, other than those fixed by the Trigonometrical branch, should not be shewn, as such points are not marked on the ground and are merely fixed to assist the topographical surveyor. They crowd the charts and necessitate these being prepared on unnecessarily large scales, and will not be required under the new system when it is introduced.

12. Brevet-Colonel G. B. Hodgson, Deputy Surveyor General, inspected No. 1 Party in the field and again in recess at Mussooree, where he also attended the conference of administrative officers. On the way to Mussooree from Calcutta he inspected Cantonment Section No. 1 at Shahjahánpur and tested the survey of that cantonment. Proceeding to Poona from Mussooree he inspected the offices of Nos. 2 and 17 Parties there and of Cantonment Section No. 2. He visited the Bengal Drawing Office at Calcutta frequently and practically superintended the standard mapping and drawing of traverse charts in this office. He has not inspected the Naini Tal Drawing Office during the season, but visited it in September 1906 and again in October 1907.

13. Mr. J. Eccles, M.A., Officiating Superintendent, Trigonometrical Surveys, visited Mussooree in June and September 1907 and inspected the recess offices of Nos. 22, 23, 24 and 26 Parties. He also inspected at Dehra Dún in September 1907 the offices of the Superintendent, Forest Surveys, No. 25 Party (T and L), and also the Survey Training School during the year from time to time.

14. Immediately after making over charge of the Forest Survey branch, Lieutenant-Colonel Gordon proceeded to Simla to discuss details connected with his new charge with the Surveyor General, after which he went to Bangalore and formed an office. On the 4th of January 1907 he went to Assam and inspected the traverse and triangulation sections of No. 20 Party which were working in the Sylhet district; he then met the Chief Secretary of the Government of Eastern Bengal and Assam and discussed the future programme of topographical surveys in that province. He then proceeded to Burma where he inspected Nos. 7, 10 and 20 Parties in the field and conferred with the Financial Commissioner, the Director of Land Records, and the Chief Conservator of Forests regarding revenue and forest surveys, and was also present at a meeting between the Lieutenant-Governor of Burma and the Surveyor General, at which future survey operations in that province were discussed.

He returned to Bangalore on the 26th of February and in July attended the conference of the administrative officers of the department at Dehra Dún and Mussooree. During the recess he frequently visited the offices of his parties with the view of securing uniformity in the style of mapping.

15. Major C. H. D. Ryder, D.S.O., R.E., Superintendent, Northern Circle, left Mussooree for Dehra Dún on the 4th October 1906, where he went into the organization of the Training party. He returned to Mussooree on the 8th idem. In the beginning of November his head-quarters office was moved to Chandbagh, Dehra Dún; he left Dehra Dún for Pesháwar on the 14th idem, his head-quarters office following him within a month. On the 29th April he proceeded to Simla to confer with the Surveyor General of India, and he returned to his head-quarters at Mussooree on the 4th May 1907.

16. Major R. T. Crichton, Superintendent, Provincial Surveys, Bengal, during the field season inspected each section working under him, at least once; from July 1st to August 13th Captain F. C. Hirst toured in Bengal and Eastern Bengal visiting each section; the latter also reported on the cadastral work done during the year by the Settlement Officers of Chota Nagpur, Faridpur and Jalpaiguri.

DISTRIBUTION OF FIELD PARTIES.

17. Field operations were carried out by 22 parties and 4 sections or detachments. Of the parties, 13 were employed on topographical surveys, 1 on principal triangulation, 4 on purely scientific operations, 2 on traverse surveys for cadastral purposes, 1 on traverse and cadastral surveys, and 1 on traverse and topographical surveys. The sections and detachments were employed on cantonment and town surveys. The following table shows the distribution according to the nature of the work on which the parties were employed:—

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale.	Administrative Superintendent.
	TRIGONOMETRICAL.				
24	India	23	Captain C. M. Browne, D. S. O., R.E.	...	S. T. S.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale.	Administrative Superintendent.
	SCIENTIFIC.				
22	India (Latitudes) . .	24	Captain H. M. Cowie, R.E. .	...	S. T. S.
23	„ (Pendulums) .	25	Major G. P. Lenox Conyngham, R.E.	...	„
25	„ (Tidal & Levelling)	28	Mr. C. F. Eckstine . . .	...	„
26	„ (Magnetic) . .	32	Captain R. H. Thomas, R.E. .	...	„
	TOPOGRAPHICAL.				
1	Central Provinces . .	37	Major A. H. B. Hume, R.E. . Lieutenant K. W. Pye, R.E. . Lieutenant M. N. MacLeod, R.E.	2″=1 M.	D. S. G.
2	Berar	39	Captain H. Wood, R.E. . Mr. C. J. Veale . . .	2″=1 M.	„
17	Bombay Presidency .	39	Mr. B. G. Gilbert-Cooper . „ S. F. Norman . . .	4″=1 M. 2″=1 M.	„
3	Lower Burma . .	41	Mr. E. F. Litchfield . Captain C. P. Gunter, R.E. .	1″=1 M.	Sup., Burma Surveys.
10	Upper Burma . .	42	Captain A. A. McHarg, R.E. .	1″=1 M. 2″=1 M.	„
11	Shan States . .	44	Captain R. H. Phillimore, R.E. . Lieutenant L. G. Crosthwait, I.A.	1½″=1 M.	„
19	Madras Presidency .	45	Lieutenant-Colonel W. J. Bytheli, R.E. Captain F. F. Hunter, I.A. . Mr. G. T. Hall . . .	1″=1 M. 2″=1 M. 4″=1 M.	„
20	Burma and Assam .	47	Major A. Mears, I.A. . Major C. W. H. Symonds, I.A. . Mr. P. F. Prunty . . .	2″=1 M. 4″=1 M.	„
9	Northern Circle . .	50	Major F. W. Pirrie, I.A. . Lieutenant S. W. S. Hamilton, R.E. Lieutenant E. C. Baker, R.E. .	2″=1 M. 4″=1 M.	Sup., Northern Circle.
12	„ . . .	51	Captain E. T. Rich, R.E. . Lieutenant S. W. S. Hamilton, R.E.	2″=1 M.	„
14	„ . . .	51	Captain H. L. Crosthwait, R.E.	2″=1 M.	„
18	„ . . .	52	Captain E. A. Tandy, R.E. .	2″=1 M.	„
Training	„ . . .	54	Mr. G. P. Tate . . .	2″=1 M.	„
	CADASTRAL & TRAVERSE.				
4	Bihár	56	Captain F. C. Hirst, I.A. . Mr. N. Bedford . . .	16″=1 M.	S. P. S., Bengal.
5	Chota Nagpur . .	57	Mr. C. S. Kraal . . .	16″=1 M.	„
6	Eastern Bengal . .	57	„ A. W. Smart . . .	Various	„
Det.	Calcutta . . .	58	„ R. B. Smart . . .	105·6″=1 M.	„
7	Burma . . .	60	„ O.D. Smart . . .	16″=1 M.	Sup., Burma Surveys.
	CANTONMENT SURVEYS.				
Section No. 1.	Meerut and Lucknow Divisions.	62	Mr. J. McHatton . . . „ F. S.Bell . . .	16″=1 M. 64″=1 M.	D. S. G.
2	Poona and Mhow Divisions.	63	Mr. L. J. Pocock . . .	16″=1 M. 64″=1 M.	„
3	Secunderabad Division .	63	„ E. G. Little . . .	12″=1 M. 16″=1 M. 48″=1 M. 64″=1 M.	„

TRIGONOMETRICAL SURVEYS.

18. The Triangulation party (No. 24) continued the series of principal triangulation trending westwards from Kalát, called the Kalát Longitudinal series. The length completed was 150 miles. Fifteen triangles were completed covering an area of 3,390 square miles, and the average triangular error was 0″·41.

SPECIAL OPERATIONS.

19. Major G. P. Lenox Conyngham, R.E., and Captain H. M. Cowie, R.E., were employed in the continuation of the gravimetric survey. Captain Cowie took observations to determine the deflection of the plumb line at 11 stations in Káthiáwár and round the Gulf of Cambay. The values obtained were in accordance with the general character of the deflections in Rajputana.

20. To determine the variation in the value of gravity Major Lenox Conyngham took pendulum observations at 12 stations in the neighbourhood of the Himalayas and of the Siwáliks, and on or near the Great Arc. The general character of the variations found was in accordance with expectation, but local anomalies of considerable amount were also disclosed. Two of Basevi's stations were included in the programme.

21. The result of Professor Dr. Hecker's observations at Jalpaiguri in 1905 have been received and found to agree perfectly with those of Major Lenox Conyngham.

22. Tidal operations were continued by No. 25 Party, observations being recorded at eight stations.

The observatory at Karachi was carried away on the 6th June by a cyclone.

23. Levelling operations were carried on in the Punjab, the United Provinces and the Presidencies of Madras and Bombay. The American "Binocular" levels were used for the first time and were found to be a great improvement.

24. Four detachments of the Magnetic party extended the survey into Burma and Assam. Vertical force magnetographs were erected at all the base-stations, and the dip circles were replaced by earth inductors.

25. The systematic observations to Himalayan peaks in connection with the difficult problem of refraction were continued. The results are of great interest, but many more are required before definite conclusions can be drawn.

26. The following statement shows the cost of the more purely scientific work of the department for the year under report :—

			₹	₹
No. 22 Party,	Astronomical			21,624
„ 23 „	Pendulums			30,520
„ 24 „	Triangulation			74,768
„ 25 „	Tidal and Levelling—			
		Tidal observations	14,873	
		Preparation of Tidal Tables	26,732	
		Levelling operations	42,903	
				84,508
„ 26 „	Magnetic—			
		Magnetic observations	11,185	
		Magnetic field work	67,394	
				78,579
		TOTAL		2,89,999

27. Surveyor Lachman Jadu, R.S., accompanied the boundary commission which was employed on the erection of pillars on the Burma-China boundary between Panghsang Nalawt and the Mè-hkong river. Few opportunities presented themselves for adding further details to the existing maps, but the adjacent portion of the Southern Shan States will be topographically surveyed by No. 11 Party in 1908-09.

TOPOGRAPHICAL SURVEYS.

28. *Central and United Provinces and Central India States.*—No. 1 Party carried out a supplementary survey on the 2-inch scale of 838 square miles of country previously surveyed on the 16-inch scale by local agency in the Central and United Provinces and a re-survey on the same scale of 664 square miles of

portions of the adjoining native states of Central India. The survey of 135 square miles of forests was revised and also the contouring of 297 square miles of former season's work which had been based on old and inaccurate trigonometrical heights. The result of the season's work is that the maps of 1,934 square miles have been brought up to date. No triangulation was done, but 816 linear miles of theodolite traverses were run to provide extra points and heights.

29. *Berar, Central Provinces.*—An area of 1,680 square miles was triangulated and 1,296 square miles were surveyed on the 2-inch scale by No. 2 Party, in connection with the training of young officers of the Provincial service. The boundaries of all A and B forests that fell into the area under survey were surveyed on the 4-inch scale for the Forest Department.

30. *Bombay Presidency.*—No. 17 Party, which had been hitherto employed exclusively on forest surveys, commenced general topographical survey this season on the 2-inch scale in the West Khandesh district and adjoining native states and re-surveyed 348 square miles previously surveyed on the 1-inch scale, and revised the survey of 2,292 square miles. An area of 2,155 square miles was triangulated in advance and 62 square miles of forests and 140 linear miles of forest boundaries were surveyed on the 4-inch scale for the Forest Department.

31. *Eastern Bengal and Assam.*—An advance section of No. 20 Party traversed and triangulated over 4,000 square miles in degree sheet 78 P in anticipation of the detail survey, which will be commenced in 1907-08 on the 2-inch scale.

32. *Burma.*—Nos. 3, 10, 11 and 20 Parties were employed on topographical surveys in Burma and surveyed 8,713 square miles, of which 5,339, including revision and supplementary work, were on the 1-inch, 1,612 on the 1½-inch, 1,711 on the 2-inch, and 51 on the 4-inch scales.

33. *Madras Presidency.*—No. 19 Party commenced topographical survey operations and surveyed 1,515 square miles on the 2-inch scale in Malabar and revised 45 square miles on the 1-inch in Mysore. 374 square miles of forest were also surveyed on the 4-inch scale in Ganjam and Coimbatore.

34. *Northern Circle.*—No. 12 Party in the Peshâwar valley triangulated 4,730 square miles and surveyed on the 2-inch scale 1,230 square miles.

No. 14 Party in the Kohât district triangulated 4,495 square miles and surveyed on the 2-inch scale 1,547 square miles.

No. 18 Party in the Bannu and Dera Ismail Khan districts triangulated 1,240 square miles, and surveyed on the 2-inch scale 1,801 square miles. 1,009 linear miles were traversed in the above districts and 626 linear miles in the Jhelum colony. In the Bâri Doâb 195 bases for revenue surveys covering an area of 1,123 square miles were laid, and this area was traversed throughout.

No. 9 Party in the Dera Ghâzi Khan district triangulated 1,897 square miles and surveyed 258 square miles on the 2-inch scale and revised 258 square miles on the 4-inch scale.

The Training party in the Jhelum district triangulated 1,059 square miles and surveyed on the 2-inch scale 322 square miles.

The total area triangulated was 18,964 square miles and the area surveyed 7,519 square miles.

The cost-rates per square mile omitting the Training party are Rs. 9-10-0 for triangulation and Rs. 44-10-0 for the detail survey. As the parties work southwards the outturn will increase and the cost-rates diminish.

All the parties recessed at Mussooree, except the Training party which was at Dehra Dún. All the parties in this circle recessing in or near Mussooree under the eye of the Circle Superintendent proved most successful and resulted in a more uniform and improved style of drawing. The want of an office, common to all parties, was however much felt, their offices being unavoidably scattered over Mussooree in bungalows rented at a heavy expense, and often very unsuitable as drawing offices.

During the winter 1907-08 a large drawing establishment will be employed at Dehra Dún to cope with the arrears of drawing.

35. *Bengal.*—The survey of a block of hills lying to the south of Monghyr was commenced, but little progress was made since it was decided during the field season to cadastrally survey this area, and most of the surveyors employed on it had to be used for traverse work preparatory for the cadastral survey.

36. *Eastern Bengal.*—The survey of the Sunderbans tract in the Khulna and 24-Parganas districts was continued; an area of 1,591 square miles was traversed and surveyed in detail on the 4-inch and 2-inch scales. The balance of the Sunderbans tract (about 1,050 square miles) will be completed during the next survey year.

37. The outturn of topographical surveys on all scales is as follows:—

	Square miles.
Central and United Provinces and Central India	1,934
Berar	1,296
Bombay	2,702
Bengal	1,642
Burma	8,713
Madras	1,934
Northern Circle	7,519
TOTAL	25,740

FOREST SURVEYS.

38. The Inspector General of Forests having agreed to a reduction in the standard scale of forest surveys from 4 inches to 2 inches to the mile, the Government of India have decided that in future all reserved forests shall, as a general rule, be surveyed on the latter scale in the course of the general programme of the Survey of India, no charge being made to the Forest Department. In cases where surveys on a larger scale are required or when surveys on the 2-inch scale are wanted apart from the regular programme of the Survey of India, the whole cost will be debitable to the Forest Department. Boundaries of forest surveyed on the 2-inch scale will be surveyed on the 4-inch scale, if required, free of charge. In consequence of this decision Nos. 9,17, 19 and 20 Parties, which have hitherto been exclusively employed on forest surveys, have now become topographical parties.

39. *Burma.*—No. 20 Party completed the survey of the Mepalè reserves in Thaungyin surveying an area of 51 square miles under the old conditions. It also surveyed 500 linear miles of forest boundary in Minbu, and, in the course of its regular programme, surveyed topographically 474 square miles of forests in the Pakkôku district (Yaw Forest Division). As 4-inch boundary surveys of these reserves were not required they were not carried out.

No. 10 Party in the course of its regular programme surveyed 148 square miles of forests in the Shwebo district (Katha Forest Division) on the 2-inch scale without a special boundary survey, as this was not required by the Forest Department.

There was a small area of forest in the Salween district included in the programme of No. 3 Party, but as its survey on the 2-inch scale would have prevented the completion of degree sheet 94 F on the 1-inch scale, the work was postponed and will be carried out in connection with the survey of the adjoining sheet.

40. The maps of the 4-inch surveys have been prepared in the Forest Survey office at Dehra Dún and published. The 4-inch boundary surveys will also be dealt with in that office. A special edition of the sheets in which forests surveyed on the 2-inch scale occur will be published on that scale for the use of the Forest Department.

41. The cost-rates of forest surveys cannot be satisfactorily compared with those of former years as the conditions were altogether different; the parties formerly engaged on forest surveys were employed principally on regular topographical surveys and the 4-inch forest surveys were only of small outlying areas carried out to complete forest blocks already commenced on that scale.

42. *Madras Presidency.*—No. 19 Party surveyed 340 square miles of reserved forest on the 4-inch scale in the Ganjam district and 34 square miles on the same scale in Coimbatore under the old conditions. 311 linear miles of forest boundary were also traversed by theodolite in Ganjam, Malabar and Trichinopoly.

43. The areas surveyed have been included in those given for topographical surveys.

CADASTRAL AND TRAVERSE SURVEYS.

44. Two cadastral parties were employed, one in Bengal (Bihár) and one in Burma. Two parties were employed on the traversing of areas in Bengal and Eastern Bengal and Assam which will be cadastrally surveyed by the Settlement Department. Record-writing over 1,845 square miles in Bihár was also carried out.

45. In Burma 509 square miles were cadastrally surveyed in the Pakôkku district completing the revenue survey of that district and 47 square miles in the Lower Chindwin and Thayetmyo districts. Six hundred and ninety-one square miles were also traversed in the latter district. Owing to the physical nature of the country the cadastral survey in the Pyapôn district was carried out *pari passu* with the traverse survey, 171 square miles being traversed and 131 square miles (including 6 of water area) cadastrally surveyed on the 16-inch scale.

46. The Government of Burma having decided that all extensive areas at present ripe for revenue surveys will have been dealt with when the programme for 1907-08, consisting of 856 square miles in Thayetmyo, Pyapôn, Pegu and Yamethin districts, is completed, the party will be broken up and all future revenue operations in the province will devolve on the local Land Records Department.

47. Copies of a preliminary edition of the maps of the added area of Rangoon town have been made over to the Revenue and Municipal authorities.

48. The total area traversed and surveyed cadastrally during the year is as follows:—

Province.	Traversing.	Cadastral Survey.
Bengal	6,309(*a*)	1,683
Eastern Bengal	1,022(*b*)	*Nil.*
Burma	862	687
TOTAL	8,193	2,370

(*a*) Includes 25 square miles of miscellaneous surveys.
(*b*) Includes 4 square miles of miscellaneous work.

CANTONMENT SURVEYS.

49. The survey of cantonments was continued by 3 small parties in the Meerut, Lucknow, Poona, Mhow and Secunderabad Divisions. The survey of 28 cantonments was completed during the season and of 3 almost completed. Of these 44,800 acres were surveyed on the 12 and 16-inch scales and 1,660 acres on the 48 and 64-inch scales. All the cantonments in the Secunderabad Division have now been completed and one of the parties has been broken up. In addition to the above outturn, most of the cantonments that were surveyed last year were contoured during the current season.

RESULTS.

50. The total outturn of detail topographical and forest surveys on all scales is 25,740* square miles against 23,312 square miles of similar surveys during the previous year. No surveys on a smaller scale than 1 inch = 1 mile were carried out during the year; the total area triangulated and traversed for topographical or forest surveys is 31,85[illegible] and 1,684 square miles respectively against 27,134 square miles for the previous year. The increase in the outturn of topographical survey and triangulation is mainly due to the reduction in the scale of forest surveys from 4 inches to 2 inches = 1 mile.

	Square miles.
* 4-inch scale	1,383
2 „	17,361
1½ „	1,612
1 „	5,384

The total area of cadastral surveys is 2,370 square miles and of the area traversed for this purpose is 8,193 square miles against 2,982 and 6,464 square miles respectively for the previous year.

The total actual area surveyed is so dependent on the scales of survey, the distances which the field parties have to cover to reach their work from their head-quarters and the nature of the country dealt with in any one

year that it is difficult to estimate the increasing efficiency of the department, but there has been a very material improvement in the class of the work performed and in the resulting maps. The scale on which the surveys have been mainly carried out this year is new to many of the surveyors who were for the most part trained to work on the 4-inch or 1-inch scales. Those previously working on the 4-inch scale strove to show on the 2-inch all the details they had previously shown in the larger scale, and those who had worked on the 1-inch scale were distressed at the additional details they found they could show on the 2-inch scale. It has altogether been a trying year for the surveyor, but it has not been wanting in instruction, and though the scale of survey is now to be reduced again to 1 inch =1 mile for general purposes, the experience gained will be beneficial and a far larger area of first class work in the coming and in future years is anticipated. The improvement in outturn can only be gradual.

HEAD-QUARTERS OFFICES, CALCUTTA.

51. The general superintendence of these offices continued under Colonel F. B. Longe, R.E., Surveyor General. The Surveyor General's and the Mathematical Instrument Offices were in charge of Brevet-Colonel T. F. B. Renny-Tailyour, R.E., up to 10th April and thereafter under Lieutenant-Colonel J. M. Fleming, I.A.; the Drawing, Engraving and Map Record and Issue Offices were under Lieutenant-Colonel J. M. Fleming up to 10th April and afterwards under Captain W. M. Coldstream, R.E. The Photo-Litho Office was under Lieutenant-Colonel Bythell till 10th November, when he was relieved by Major W. C. Hedley, R.E. After the re-arrangement of work of the Photo-Litho Office Major Hedley was placed in charge of the Drawing and Reproducing Offices and under him were placed two officers, Major J. M. Burn, R.E., and Captain W. M. Coldstream, R.E., to supervise the work of the Drawing, Engraving and Map Record and Issue Offices and the Photo-Litho Office, respectively.

52. *Drawing Office.*—The appointment of the expert such as Major Hedley to the combined charge of the Drawing and Photo-Litho Offices which was effected during the year under report is already having beneficial effect, in that all maps now sent to the Printing Office are as complete as they can be, for fewer proofs are required and the number of corrections to be carried out on plates has been most materially reduced. His appointment has also enabled the officer in charge of the Drawing Office to devote far more time to the actual supervision of the mapping, owing to his being relieved of the mass of the correspondence which is now dealt with by the Superintendent himself.

53. The most important work before the Drawing Office should be the compilation of the $\frac{1}{\text{million}}$ sheets, the 32-mile and the smaller scale maps of India, and every endeavour is now being made to put the best available draftsmen on this work. In the past time, these men have been far too much occupied in examining and correcting drawings (which have been sent in an incomplete state either by field parties or by other departments) before despatching them to the Photo Office for publication. It is hoped that in future but few maps will have to be treated in this way and that the mass will go straight to the Photo-Litho Office with the orders of the Superintendent of the Map Publication.

54. A table showing the maps that have been dealt with during the year and the number of maps that have been published is appended. From this it will be seen that the number of publications is very small as compared to the work in hand. This is largely due to the fact that the symbols and mode of showing details on the standard sheets was under discussion throughout the greater part of the year, and also to the fact that most of the maps received from outside were incomplete in some form or other. The symbols have now been decided on and publication should proceed more rapidly in future.

55. Owing to the receipt of fresh orders regarding the colouring of the small scale maps of India from the Secretary of State, the publication of these maps is still in abeyance, but the 32-mile map of India will be published very shortly.

56. Owing to the demand for 1-inch maps it has been found necessary to continue the compilation of standard sheets on that scale from old surveys in order to avoid having to reprint such maps in several sections but the actual work on these maps has been cut down as far as possible, and it is estimated that in two years' time the stock of all standard sheets for which there is any demand will have been replenished.

Statement of work in hand and completed during 1906-07.

Class of Map.	Scale.	Total number of sheets in hand during 1906-07.	Number of sheets published.
General Map of India	$\frac{1}{32}$ to $\frac{1}{256}$	34	6
India and adjacent countries	$\frac{1}{M}$	18	4
Provincial Maps	various	23	...
District Maps	1, $\frac{1}{2}$ & $\frac{1}{4}$	43	11
Standard Sheets	various	951	381
Degree Sheets	$\frac{1}{4}$	4	4
Administration Report Maps	$\frac{1}{8}$ & $\frac{1}{12}$	35	3
Plans of Cities and Cantonments	various	147	50
Triangulation and Traverse Charts	1, $\frac{1}{2}$ & $\frac{1}{8}$	83	36
Index Maps (including Index showing progress of work)	various	74	64
Miscellaneous Maps, etc.	...	9	3
Various maps for other departments	various	236	167

57. *Engraving Office.*—The Engraving Office has been very largely employed in correcting and bringing up to date a large number of miscellaneous maps, amongst which are the 64-mile, 80-mile, 192-mile and a few provincial and district maps.

The following new provincial maps have been almost completed:—

Bengal, Madras, Punjab and Gujarat.

A new 3-inch map of Calcutta has been completed.

The following new maps have been put in hand and will form the chief work of the office for the next few years:—

32-mile India in 12 sheets.

The $\frac{1}{M}$ series, 13 sheets in hand.

The printing section pulled 49,914 impressions.

58. *Photo-Litho Office.*—From October 1st to November 11th, 1906, the Photo-Litho Office was in charge of Major W. J. Bythell, R.E., when he was relieved by Major Hedley, R.E. On April 11th Major Hedley handed over the direct charge to Captain W. M. Coldstream, R.E., and assumed general charge of both the Drawing and Photo-Litho Offices.

59. His first step was to completely separate the Photo and Litho sections and the Stores section These had previously all been under the general superintendence of Mr. R. Fogarty, and the officer in charge dealt with each section through him. He preferred to deal direct with each section and therefore abolished the post of Head Assistant and made Mr. Fogarty, Superintendent, Litho, and Mr. Taylor, Superintendent, Photo, and put Mr. Meade in charge of the Stores, making him independent of both the other sections. The Photogravure section which was formerly independent, was placed under the Superintendent, Photo. In describing the changes which have been made it will be convenient to start with the Photo section.

60. The first thing he did was to abolish altogether the system of publishing maps by photo transfers. Formerly when a reprint of an old standard map was required each quarter sheet was photographed separately and the photo transfers were laid down and fitted together on the zinc plate, the footnotes, scale, etc., etc., being afterwards added by type transfer. This was a very troublesome method and had the great disadvantage that accuracy of scale could not be attained by it. The four quarters of the map are now pinned up on the board in position, with all the accessory work quite complete. One negative only is taken, a helio is made and sent to litho. An immense simplification of the work has thus resulted, with at the same time a considerable improvement in quality.

61. Every care is now taken that each negative is as good as can be obtained from the original. Every negative is inspected and passed by the Superintendent, Photo, who pays particular attention to scale. Every original which is received has the dimensions on which it is to be published marked on it, and it is most important that the greatest accuracy be observed in this part of the work.

62. *Negative Touching.*—The section for "touching" negatives has been very much increased. Formerly little was attempted beyond pointing out defects or pin holes in them, and necessary corrections or additions were always made on the plate. Our present method is to make such corrections on the negative, and thus ensure a fresh and untouched helio, from which far better results can always be obtained. This change of method has resulted in a large increase of negative touching, but a corresponding decrease in the work on the zinc plates. It has been found possible to supply the necessary staff of negative touchers from the younger litho draftsmen and zinc correctors, and several of these men have already become fairly expert at drawing on glass, making additions or corrections or writing new names. It is usual in England to call a man who is expert at such work a glass engraver, and there is all the difference in the world between a glass engraver and a mere negative "duffer."

This section has become of the very greatest importance in view of the fact that we have now begun the publication of the new maps in 5 colours. Unless the duffing and subsequent touching up is well and carefully done, the resultant map must be a failure. This work has been quite new to nearly all the men and many errors have been made, but there has been a gradual improvement which is bound to continue, and in another two years' time he anticipates no trouble at all in this section.

63. *Helio Section.*—The negatives having been duffed and touched go to the Helio section. The quality of the helio plates now turned out leaves very little to be desired. There are differences in the methods employed here and at the Ordnance Survey at Southampton, but they are comparatively unimportant. It is much more important that whatever method is employed it should be well and carefully done. Every plate is now inspected and initialled by the Superintendent, Photo, before being sent to the Litho section and it is to this efficient superintendence that Major Hedley attributes the improvement in quality.

64. *Vandyke Section.*—The direct zinc printing, or Vandyke section as it is called, is quite efficient and turns out a large amount of work. The methods are not quite the same as at Southampton, but are suitable for the class of labour available. Most of the work received is drawn on thin paper or on tracing paper, but many originals on thick drawing paper have been successfully reproduced, and there is no difficulty in vandyking through thick paper provided the drawing is good.

65. *Photogravure Section.*—This section, as has been already mentioned, has been placed under the Superintendent, Photo, instead of being under a separate head. There is nothing special to report.

66. Allusion was made last year to Mr. Taylor's process for reproducing a hill-shaded drawing without any hand touching, and a map illustrating this method was published. Further experience has confirmed the high opinion then formed of this method, and it is intended to use it for the reproduction of all brush drawings.

67. Major Hedley considers that the Photo branch is now in good order. The weak spot is the negative touching section, but this will undoubtedly improve with more time and practice. The rest of the branch is capable of dealing with far more work than it now receives. He considers that our lenses, although good, are not quite all that might be desired. We have, however, ordered one of the best lenses and on its arrival he expects still further improvement in the negatives.

Major Hedley reports that the work of reorganizing the Photo branch has been made comparatively easy by the zeal, skill and energy of Mr. Taylor. He brought out Sergeant Lucas, R.E., with him as his expert adviser in photographic matters, and he reports that he has been most useful.

68. *Lithographic Branch.*—This branch is now under Mr. R. Fogarty, who is able to devote his whole time to it, having been relieved of all responsibility for the Photo branch. The great change in this branch has been the placing of all the printing work under Mr. Vandyke. Formerly it was partly under Mr. LeFranc and partly under Mr. Vandyke. All the printers both for hand presses and machines, are now downstairs, with the exception of those printing cadastral maps. On the other hand all the litho draftsmen, zinc correctors and proof examiners are upstairs under the general superintendence of Mr. LeFranc. Mr. Vandyke is undoubtedly our greatest expert in all kinds of printing, and the quality of the work has benefited enormously by the new arrangement.

69. The printing has been made very much easier by the fact that helio plates are now received practically complete. All the tedious work of setting up and transferring the footnotes is thus avoided and the corrections to the plates are now as a rule very small, and their quality for printing from is proportionately improved.

70. The principle hitherto observed has been to supply proofs for everything and to expect to have to carry out large alterations and corrections on the plate. The principle now worked on is to have the originals as complete and accurate as possible, the Photo-Litho branch accepting full responsibility for the accurate reproduction of the original. In the case of departmental maps printed in black only, proofs are not now supplied, but the work of reproduction is carried straight to completion. The saving of labour all round thus effected is incalculable.

71. *Coloured Maps.*—The department has this year begun the preparation and publication of the new coloured maps. Some difficulty was anticipated in registration as it was feared the plates might not be all the same size. Owing to the care now taken in the Photo section in measuring the negatives, these fears have not been realized, and there has been no difficulty in registration, though the plates have been prepared from different negatives of the same original. In many cases, however, the hills, which are drawn on a separate original, have been found impossible to register, although the plates were the same size. This has been due to faulty drawing, but under new rules the hills will be drawn on blue prints of the outline and Major Hedley anticipates no such difficulty in future. He reports that he has been very pleased with the way in which Mr. Vandyke, assisted by Mr. Colquhoun, has carried out the proving and printing of these maps.

72. *Graining plates.*—The graining of zinc plates by hand has been abolished and all the work is now done by machines which were designed by Mr. S. M. Coard of the Engraving branch. It is all carried out in what used to be the carpenter's shed, instead of being more or less scattered over the office. This admits of far more efficient superintendence, and it is more to this extra supervision than to the substitution of machines for hand work that Major Hedley attributes the great improvement in the quality of the grain obtained. Much of the improvement in Helio, Vandyke, and Printing sections is due to this improvement in the zinc graining. A well grained plate is the foundation of all good work on zinc.

73. *Paper.*—Hitherto standard sheets have always been printed on thick paper, and maps, mostly extra departmental, which were required to fold were printed on bank-post. A map printed on thick paper will not fold without cracking, and for this reason and also on account of its bulk it is quite unfitted for use in the field. On the other hand bank-post, although a tough paper which folds well, is a bad printing paper. A new paper which will fold without tearing, which is durable, and which at the same time is a very good printing paper has been introduced. Of each edition of the 1-inch maps, both old and new, and of the degree sheets, three quarters will be printed on this thin Rag-litho paper and $\frac{1}{4}$ on thick paper. Those printed on Rag-litho paper can then be folded for binding with a report, or for use in the field, and experience will soon show whether there is any demand for thick paper copies. It is anticipated that the thin paper will be generally preferred. Thin paper has two other great advantages, inasmuch as its price is less than one-third that of the thick, and it can be stored in about half the space. This latter is a very important point as the problem of the storage of maps was becoming somewhat pressing.

74. *Store fittings, etc.*—Many minor improvements have been made in the Litho section which may be briefly referred to. Many old and useless zinc plates have been cleaned off and either re-grained or sold as old zinc. Proper racks have been made for those plates which had to be kept and a register has been made of them. Great attention is now paid to keeping the whole place clean, and all old and useless papers, stores, etc., have been either destroyed, sold, or returned to store. New benches and tables have been provided to the great convenience of the printers, and new racks from which paper can be suspended from the ceiling for seasoning have been supplied. For all our new fittings, some of which have been mentioned, this section is indebted to the assistance of the Mathematical Instrument Office.

75. *Type Section.*—The former Superintendent, Mr. DePyvah, has retired and it has been found possible to continue the section under the charge of the principal native assistant. The space occupied by this section would be very valuable for storage room, and it will probably be abolished or transferred to Dehra Dún.

76. *Store Section.*—Major Hedley thought it best that the Store section should be quite independent of the Photo and the Litho. He therefore took Mr. Meade out of the Photo section and placed him in charge of the stores, with Mr. Tulloch as his assistant. Mr. Meade has shown much zeal and energy in rearranging the stores and in preparing new store ledgers. This work was very urgently needed. Stock is now being taken and all stores of every description which come into the office are now taken on charge by the store-keeper and issued with the proper vouchers to the sections for whose use they are required. This is very far from having been the case in the past. Stock had not been taken for years, but it is absolutely necessary in the future that it should be taken periodically and systematically.

The Store section is much cramped for room.

77. *General Remarks.*—Major Hedley further reports as under: "I have "already said that the department has suffered very much in the past from the "fact that originals sent for reproduction were seldom complete, and that large "corrections in the proof stage were looked upon as a matter of course. I wish "to emphasize this point again. It is no exaggeration to say that the corrections "took two or three times as much time and trouble as the reproduction of a correct "drawing. This has now I hope been put right. Unless originals are correct a "reproduction office does not have a fair chance."

"The department has also suffered from the complete want of a proper "system of registration. A map was taken in hand, begun and lost sight of. "Many maps were in hand for years, especially departmental maps, as reminders "from outside usually resulted in extra-departmental maps being given the prece- "dence. It was, however, by no means uncommon to find extra-departmental jobs "which had also been in hand for years. It appears to have been the custom to "take up any job we were asked to do without considering whether it could be "done in a reasonable time, without interfering with our proper departmental "work."

"A proper system of registering all work, not only as it comes into the office, "but as it passes from one department to another, has now been introduced and "returns are now prepared monthly showing all work which has been in hand more "than three months. I hope that we may be able to complete all simple work we "take in hand, and specially reprints, within three months. It is just as easy to "work close up as to have a balance of 6 months' arrears. If we cannot do outside "work within a reasonable time, and without interfering with our own maps, I refuse "it altogether. It is far better to refuse it than to take it in hand and not do it for "years. There is usually no difficulty in reproducing any map which is properly "drawn for photography, or which is based on one of our own maps, but we always "refuse to reproduce rough drawings in many colours such as are very commonly "received. There are two exceptions to this rule. We never refuse work for the "Foreign Office or for the Military authorities if we can possibly manage "to do it."

Monthly Report.—"The old form of monthly report has been changed. "The new report gives the progress for the month, and the balance of work out- "standing at the end of the month, for each section of the office. I look upon this "as a most valuable reform. It enables the officer in charge and the Surveyor "General to see at once when work is accumulating in any section of the office "and to take steps accordingly."

"An accurate account is now kept of the cost of every job. This gives "a certain amount of work, but it is undoubtedly necessary and well worth the "trouble."

"I think I may say the department is now running on the proper lines, "though a few small changes are still necessary; but I cannot say that the depart- "ment as a whole is really efficient. It does a certain amount of work and does it "well, but its outturn is far short of what it is capable of. What is still lacking is "zeal and energy. There is no incentive to the men to work. They know that "their pay and prospects will remain exactly the same whether they work well or "badly. No workshop can be really efficient under such conditions, although

"there will always be some men, and our office is no exception to the rule, who do "their level best under any conditions. As you know, I have submitted proposals "for remedying this state of affairs and I hope they may soon be approved. The "pay of many of the men is too small. The printers especially are very much "underpaid and (I refer to the natives) are not drawn from a sufficiently intelligent "or educated class to be really efficient. They can do simple work moderately "well under close supervision. That is all you can say for them. Here also im- "provement depends on the Surveyor General getting complete control of the "pay and promotion of the men."

"There is a great want of elasticity in the office. The office hours are very "short, only 6 hours a day, and the pay is so small that many (possibly most) "of the office employés work before and after office hours to supplement their "income drawn from the office. Working extra time is almost unknown, and yet "it would often be very convenient. I believe that overtime is often worked at "the Mint and at the Government Printing Office, and that the men get extra pay "for it. I think the same system might well be introduced here."

* * * * *

Climate.—"I have now had a year's experience of the climate of Calcutta. "I do not think it presents any serious difficulties to turning out good printing "work, and the photographic difficulties are such as can be overcome. It "would, however, be far pleasanter to work in a cooler and drier climate and such "a change would probably conduce to greater efficiency. A move from Calcutta "would also be as good as an increase of pay for the employés, many of whom "find it almost impossible to live in Calcutta on their present salary."

Officer in charge.—"It is absolutely necessary for the efficiency of the "office that it should be in charge of an officer who understands the work and this "officer should hold the post for at least 4 years. It is quite useless to put an "officer in charge who has had no experience of this kind of work. He is bound "to be completely in the hands of his subordinates. It is not necessary for him to "be as good a photographer as Mr. Taylor or as good a printer as Mr. Vandyke, "but he must know the proper organization, be able to know good work from bad, "be able to say whether a man is doing the proper amount of work, be able to say "how a map should be reproduced, and many other things which must be learnt. "It would take an officer about a year to get a fair knowledge of these things with "an experienced officer to teach him. I consider it of the first importance to "have a properly trained officer always in charge, and unless this is provided for "it is hopeless to expect a high standard of work."

"The following table shows the outturn for each of the last three years:—

Litho Section.

Year.	Class.	Number of pulls.	Number of maps in black.	Number of coloured maps.	Type Section.	
					Pulls.	Copies.
1904-05	Departmental	396,662	...	...	...	...
	Extra-Departmental	738,165	...	...	...	...
	Cadastral	61,481	...	.	...	...
	Total	1,196,308	827,705	84,689	2,292,749	1,209,953
1905-06	Departmental	425,961	...	...	...	...
	Extra-Departmental	811,629	...	...	...	...
	Cadastral	47,378	...	...	...	...
	Total	1,284,968	825,643	106,971	1,816,405	972,525
1906-07	Departmental	341,887	...	...	...	...
	Extra-Departmental	683,774	...	...	...	...
	Cadastral	97,340	...	...	...	...
	Total	1,123,001	696,336	110,681	2,124,148	1,065,582

"Our output of litho work this year has been considerably affected by the "fact that although there has been abundance of work for the large machines, the "small machines have often been idle through want of work. This year also for "the first time the 16,000 Weather Charts which are printed monthly have been "printed in the Type section instead of the Litho section. Our average runs are "very small and a monthly run of 16,000 simple maps greatly helped our total "output."

"The total cost of the office during the year has amounted to R2,79,140; "under the main heads of supervision R24,419, establishment R1,22,864, "contingencies (including cost of materials and chemicals procured locally) "R30,246, stores from England R1,01,610. This last amount is approximate "only as it represents the value of stores not yet fully expended which were "received from England on the annual indent of the preceding year."

"A sum of R42,828 has been recovered by book transfer for work done "for other departments and in cash from private individuals. The value of "work done for the Government of India and for the Survey of India is not "charged."

78. *Map Record and Issue Office.*—The number of maps issued during the year was 103,502 sheets of an aggregate value of R1,20,984. Of this total the maps supplied to Government officials on book debit amounted to R40,135, those to the India Office to R5,739, and to Agents R8,344. The sum of R19,106 was also realized in cash from sales to private individuals.

79. The number of new editions published was 698, and of reprints 181. The number of original maps, volumes of computation, etc., issued from store to other departments or branches of the office was 5,471, of which 5,224 were received back.

80. The transfer of the Forest maps was continued during the year and 11,697 sheets were sent to the Superintendent, Forest Map Office, Dehra Dún, for storage.

81. The overhauling and re-registering of original maps and volumes was steadily proceeded with. The plane-table sections of some 8,000 sheets, together with 1,304 fair sheets and 1,634 volumes, were re-registered and arranged. The map and manuscript stores are in good order, and much credit is due to Mr. Rundlett, the curator.

82. The revision of the catalogues was held in abeyance as a new system is to be introduced. The great difficulty which this office has to compete with in this matter is that a very large number of the maps which are still catalogued are out of print, and many are so old that they will never be reprinted. The result of this is that orders frequently cannot be completely complied with, and much inconvenience and extra labour is involved. The first step in the re-organization of this office will be the preparation of a new and complete catalogue for the whole of India and it will contain only the maps of which it is intended to keep a stock. It will probably be printed annually with corrections to date. Now that the new system of numbering the topographical maps is in force and the new index maps have been completed, the preparation of a complete catalogue will be simple and it should be available within a few months. The chief difficulty will be to decide which of the older maps are to be retained on the lists and which rejected.

83. The sale of maps to the public is still very small. This is chiefly due to the small number of agencies at which they are procurable. Arrangements will be made to establish agencies in all the larger towns during the coming year and it is expected that a much larger demand for the general maps of India and for local maps will arise. Decentralisation is essential in this direction.

84. The system of hand-colouring maps before issue which has been one of the main causes of delay in complying with demands for standard sheets on the 1-inch scale will be gradually abolished; all such maps will in future be printed in colours, but a certain amount of hand colouring will have to be continued on the degree sheets and $\frac{1}{\text{million}}$ sheets for some years to come at any rate.

85. *Mathematical Instrument Office.*—During the year under report, *i.e.*, from 1st April 1906 to 31st March 1907, there has been a decrease in the demands made on this office. For each of the last three years the value of the instruments, etc., issued was R3,54,005, R4,22,179 and R3,82,345; the value of repairs to instruments received for that purpose and returned in a serviceable

condition was R40,069, R41,818 and R42,181; and the value of instruments received from Government officers as "no longer required" was R85,994, R76,096 and R58,128.

The book value of instruments, etc., in the serviceable store at the end of each of the last three years was R3,92,653, R4,53,251 and R5,35,535. The increase in hand at end of the year under report compared with the previous year is due to a decrease in the demand for instruments.

The book value of the stock of instruments, etc., in the repairable store at the end of each of the last three years was R1,46,734, R1,19,907 and R1,12,389. As usual, no instruments for which there was demand were kept in the repairable store for any length of time; they were sent to the workshop for repairs and transferred to the serviceable store for issue as soon as possible.

Two "profit and loss" statements have been prepared—one for the stores branch and the other for the workshop. The stores show a gain of R2,956, and the workshop a loss of R7,988. This loss is chiefly due to a larger expenditure having been incurred during the year under report than in the previous year, owing to a sum of R6,695 having had to be paid to the men on account of grain compensation, nothing on this account having been paid in the previous year. The number of men and boys employed at the end of each of the last three years was 352,421 and 451. The total value of the issues during the year under report shown in the "profit and loss" statement on account of stores amounted to R3,93,952 as against R4,32,013 in the previous year, and the value of the work done in the workshop during each of the last three years was R1,58,958, R2,01,083 and R2,16,730.

The value of the instruments, etc., manufactured in the workshop for the serviceable store during each of the last three years was R64,188, R82,638 and R87,588. The value of instruments, etc., purchased locally during each of the last three years was R14,405, R17,810 and R4,189.

The value of instruments, material, etc., obtained from England through the Director General of Stores during each of the last three years was R1,91,113, R2,87,740 and R4,36,240.

During the year under report steam for working the machinery was superseded by electric motors, the existing steam engine being of insufficient power to drive all the available machines. The carpenter's and tinman's establishment of the Photo-Litho Office was taken under the supervision of this office during the year.

Stock-taking has been taken seriously in hand and in a short time the stores and workshops should be in thoroughly satisfactory order, though the space available for the workmen is very cramped.

Extensions of the buildings are proposed partly to enable the manufactures to be increased and corresponding reductions to be made in the number of instruments received from England and partly to lessen the danger of accidents to the workmen.

This department is being re-organised, and an additional specialist has been obtained from England through the Secretary of State. There are therefore 3 thoroughly trained European managers in the place of the 2 mathematical instrument makers who had until this year to superintendent the whole of this large and growing industry.

BRANCH OFFICES.

TRIGONOMETRICAL OFFICE.

86. The superintendence of the Trigonometrical Survey remained in the hands of Lieutenant-Colonel S. G. Burrard, R.E., F.R.S., till his departure on combined leave on 19th March, when he was relieved by Mr. J. Eccles, M.A., who also held charge of the technical offices throughout the year.

Mr. T. A. Pope joined the office on 28th January 1907, and was given the superintendence of the Photographic Office. He was also placed in charge of the Forest Survey Office from 7th February 1907.

Lieutenant F. F. Hunter, I. A., who joined on 27th April 1906 on special duty, was transferred on 17th May 1907 to No. 19 Party, Lieutenants J. D. Campbell, R.E., E. B. Cardew, R.E., R. Foster, I.A., H. T. Morshead, R.E., G. F. T. Oakes, R.E., F. J. M. King, R.E., and R. S. M. Harrison, I.A., who were appointed during the year, were put through a course of topographical and astronomical work.

Lieutenants Campbell and Morshead unfortunately contracted enteric and were invalided to England on 6th June 1907. The other officers were also put through a complete course of principal triangulation. Fifteen Sub-Assistant Superintendents were put through a course of training during the year and three officers were instructed in exploration work.

87. The following computations were carried out in the Computing Office, for incorporation with the Synoptical volume of the North-East Longitudinal series:—

Computations of latitudes, longitudes and azimuths of—

(1) Snow peak triangulation in west, central and east Nepal.
(2) The Sikkim triangulation peaks.
(3) Gundak river triangulation.

Computations of the heights of—

(1) Himalayan peaks with modified co-efficients.
(2) Dehra Dún and Jaunsar Báwár triangulation.
(3) Barckley's snow peaks.
(4) Ryall's Milam-Hundes triangulation.

The azimuth and co-ordinate lists of the North-East Longitudinal series are in hand.

Computations in connection with Colonel Burrard's paper on the Himalayan geography were completed.

The co-ordinates of the points of the Dehra Dún charts were altered from their former origins to the east end of the Base line.

The longitudes in the Synoptical volumes of the Great Arc series, section 8°-18° and of the Khanpisura series were corrected to Greenwich terms.

The closing errors in the levelling from Sujàwal to Sukkur and Sukkur to Shikàrpur were dispersed.

Observations for heights received from Mr. Calvert, I. C. S., and M. Rigodi Righi were reduced.

Compilations for the Levelling volume which have been in hand for some years are now nearing completion.

The charts of the Kalát series and the maps for Colonel Burrard's paper on Himalayan geography were examined and passed. The drawing and checking of the rays for degree charts of the North-East Longitudinal series are in hand.

The compilation of data for trans-frontier degree charts is in hand.

Professional Volume XVIII of the Survey of India was printed and distributed.

The printing of the Synoptical volume of the North-East Longitudinal series is progressing.

The meteorological observations continued as usual.

The necessary professional aid in connection with the protection of stations was rendered to the office of the Superintendent, Trigonometrical Surveys.

598 stations were repaired by the district officers at a cost of R3,605-2-9.

Out of 333 districts from which the reports are annually due, 20 failed to make returns.

In the Drawing Office the following maps were either wholly or partly drawn and sent to press:—

(1) One North-East Frontier sheet on scale 16 miles=1 inch.
(2) One North-East Frontier sheet on scale 8 miles=1 inch.
(3) Map of Nepal, 2nd edition, on scale 16 miles=1 inch.
(4) Specimen triangulation chart.
(5) Index route map of the Western Himalayas, etc.
(6) Two standard sheets of the United Provinces.
(7) One standard sheet of the Punjab.
(8) Four 4-inch sheets of Punjab for publication on half scale.
(9) Four Triangulation charts.
(10) Fourteen Sind level sheets.
(11) Index map to level sheets in India and Burma.
(12) Five miscellaneous maps.
(13) One diagram for Great Trigonometrical Survey, Professional Volume No. II, and five for Professional Paper No. 10.

While the following are nearly ready :—

(1) One Sind level sheet.

(2) Six Punjab level sheets.

The following are still in hand :—

(1) Four sheets of the map of India and adjacent countries.

(2) Six Punjab level sheets.

(3) Forty-four degree-triangulation charts of the North-East Longitudinal series.

Headings, footnotes (including symbols) and area-statements were completed on 197 maps which were also sent to press.

The proofs of all maps have been examined and corrections carried out as usual, and a careful scrutiny given to all the printed copies before issue.

2,844 maps were coloured.

1,177 maps and diagrams were photographed against 983 during 1905-06 and 223,186 pulls taken against 108,064 in the same period. The increase in pulls is due to the introduction of a printing-machine worked by a gas-engine which has been in use since 15th April 1907.

88. As soon as the simultaneous reduction of the level network has been completed next summer it is proposed to fix the final values of the heights of all bench marks throughout India and to correct and republish all the Levelling pamphlets. The present series of pamphlets, each of which deals with one line of levels, has proved inconvenient and it is proposed to catalogue the pamphlets in future by areas and not by lines so that all the bench marks falling in each sheet of the $\frac{1}{\text{million}}$ map series will be found in a separate Levelling pamphlet for that sheet.

FOREST SURVEY OFFICE.

89. This office continued under the superintendence of Major P. J. Gordon, I.A., Superintendent of Forest Surveys, until the 15th October 1906, when that officer was transferred to another appointment and the Forest Survey Branch as such ceased to exist. The head-quarters office, however, is being maintained for the storage and issue of Forest maps and records, and for the preparation of Forest maps of various kinds. From the 15th October 1906 till the 7th February 1907 the charge was held by Mr. C. F. Erskine, and from the latter date by Mr. T. A. Pope on his return from furlough.

During the year 221 maps were sent to press and 233 were published at Dehra Dún. These numbers are smaller than last year, owing chiefly to the exclusion of all Forest maps of the Bombay presidency, as these no longer pass through this office, but are sent direct to the Poona Photo-Zinco Office for publication. 11,100 maps were issued, of which 6,450 were coloured and 3,210 mounted in book form.

A sum of R1,750 was realised by the sale of maps, or more than double the amount realised last year.

In accordance with the recommendations of the Survey Committee, arrangements were made for the storage in this office of the entire stock of Forest maps hitherto stored in and issued from the Map Record and Issue Office, Calcutta. A complete set of new racks for the accommodation of these maps is under construction and was nearly completed at the close of the year. Much of the Calcutta stock has already been transferred, and it is expected that the remainder will follow shortly.

LOCAL DRAWING OFFICES.

90.—*Mussooree Drawing Office.*—The Mussooree Drawing Office was this year placed under the administration of the Superintendent, Northern Circle, and was in charge of Mr. R. R. Dickinson, Extra Deputy Superintendent, 2nd grade, for the whole year.

Personnel.

Provincial Officers:

Messrs. R. R. Dickinson, in charge and W. J. Cornelius (Retired Provincial Officers).

Subordinate Establishment:

Surveyor, 5 permanent and 12 temporary Draftsmen, and 1 Writer.

Of the sheets of the India and adjacent countries series, 10 sheets have been dealt with during the year; of these two were completed and sent to press for publication, another was completed and sent to press for blue prints for hill sheet, and another has been examined and is under correction and will be sent to press shortly. Work has been started on four new sheets and the skeletons of three are nearly finished and the fourth is about one-eighth done.

As usual this office has got through a large amount of miscellaneous work; was also able to lend assistance in the shape of three draftsmen to No. 18 Party from 27th March to 31st May 1907, six draftsmen to triangulation section of above party from 19th June to 31st August 1907, one senior draftsman to No. 9 Party from 29th July to 30th September 1907, and three draftsmen to No. 15 Party from 17th September to 30th September 1907.

91. *Burma Drawing Office.*—This office was under the charge of Mr. T. Shaw, Extra Deputy Superintendent, throughout the year and was employed on the compilation of Degree sheets and index maps and the fair drawing of arrears of standard mapping and the correction of fair sheets. The training of young draftsmen was also continued.

A lithographic press was set up at the end of the year and arrangements will be made to prepare in this office, by the Vandyke process, the blue print reproductions of standard sheets for the contour sheets, which are required in order to ensure accurate registration. During the year under report there was considerable inconvenience and delay owing to this having had to be carried out at Calcutta.

This office will now be absorbed in that of the Superintendent in charge of Burma Surveys.

92. *United Provinces Drawing Office.*—The compilation of standard maps for publication on the 1-inch scale from recent cadastral revision survey was continued and also of charts of the traversing connected therewith. Mr. J. M. Kennedy, Extra Assistant Superintendent, 2nd grade, remained in charge throughout the season, and in September 1907 Mr. F. W. Marten, Sub-Assistant Superintendent, 1st grade, was transferred to this office from Bengal Surveys to assist him. The subordinate establishment has been considerably reduced as most of the draftsmen are newly entertained and those who have shown no promise of becoming really efficient draftsmen have been discharged. At the end of the season the number of draftsmen was 24 and computors 3.

93. One sheet, comprising the two new standard sheets $63\frac{I}{1\&3}$, was drawn in the old form, and 13, *viz.*, $63\frac{J}{12\&16}$, $63\frac{K}{14}$, $63\frac{N}{4,8,12,16}$, $63\frac{O}{1,2,5,9}$ and $63\frac{G}{11\&15}$ were drawn in the new style. The last two sheets were drawn from 2-inch topographical survey executed by No. 14 Party. All these sheets were sent to Calcutta for publication. Of traverse charts, 14 were drawn and additions were made to 11 which had been partly drawn by No. 14 Party, and all were sent to Calcutta for publication. Four district maps of Allahabad, Fatehpur, Kheri and Bahraich were also drawn, and those of the first three districts were sent to Calcutta for publication.

ESTABLISHMENT.

94. During the year under report the department has lost the services of three Imperial officers, *viz.*, by the retirement of Mr. E. F. Litchfield, the death of Lieutenant H. S. May, R.E., and by the reversion to the Home service of Major A. H. B. Hume, R.E.

The following officers have been appointed to the department:—Lieutenants J. D. Campbell, E. B. Cardew, H. T. Morshead, J. F. T. Oakes and F. J. M. King, Royal Engineers, and Lieutenants R. Foster and R. S. M. Harrison, Indian Army.

95. From the Provincial service four officers have retired:—Messrs. G. T. Hall, W. H. Penrose, R. R. Dickinson and J. Marten; one resigned:—Mr. D. J. Hunter; three died:—Messrs. C. D. Simons, J. G. Jamieson and A. G. Harrington; while Mr. W. J. Beedham was discharged as unsuited to the department.

Sixteen officers have been appointed to the Provincial service as probationers.

96. Lieutenant H. S. May, Royal Engineers, Assistant Superintendent, 2nd grade, died of fever in Hill Tipperah on the 14th April 1907. He received his

commission in the Royal Engineers on the 22nd November 1899, and, after serving in the South African war from March 1901 to the end of the war, for which he received the medal and 5 clasps, arrived in India in 1903 and was on the 7th June 1904 appointed to the Survey of India. For many weeks before he died he had been suffering from severe fever, but his high sense of duty led him to struggle on; he continued to work until he was absolutely prostrated and he died before medical aid could reach him.

Lieutenant May was an officer of great promise and his death was a severe loss to the department.

EXPENDITURE.

97. The total cost of the department for the year ending 31st March 1907 was R30,59,249 against an estimated cost for 1907-08 of R35,06,220. The increase which at first sight appears large, is attributable to many causes, most of which are unavoidable, some of which are politic in that the work will be done quicker and the expenditure on it will be less than if it were spread out over several seasons.

The estimated expenditure on Topographical surveys has gone up from R11,86,000 to R17,67,180. This is due to the absorption of the forest survey parties and the transfer of an additional party to the frontier, as well as to the endeavours which are being made to work off all arrears of mapping, to the necessity for providing for compensation for dearness of provisions, and to the large number of parties which are working in areas where local allowances and travelling allowances at enhanced rates are admissible. It is also due to the increase in the number of Imperial and Provincial officers under training and to the large number of soldier-surveyors attached to the field parties for instruction. The estimated expenditure under the heads Trigonometrical parties has risen from R2,57,000 to R3,67,000 approximately. In the case of No. 24 Party there is an increase of R68,000 alone, which is accounted for by the fact that there are now two sections, one triangulating in the extreme west of Baluchistan and the other in the extreme east of the Shan States, both of which areas are very expensive and difficult of access; but a few years will see this work completed, and the work has to be hurried on in order to afford basis from which the topographical surveyors can break down. The cost of the Magnetic party has gone up by R12,000 owing to its work being in Burma, but this will be completed and the expenditure on this survey will be considerably reduced in future as the general survey will be completed this year and the detail survey of small areas only will be undertaken in future. There is also an increase of R14,000 in the Tidal and Levelling party owing to the formation of a new levelling detachment, and of R12,000 in the Astronomical party.

The expenditure on cantonment surveys for 1907-08 is estimated at R66,000 as compared with R63,000 in the year under report but these surveys will shortly be finished and practically the whole of this amount will be saved within the next two years. There is also an increase of R30,000 approximately on account of Mathematical Instruments, which is due to the necessity of equipping the increased establishments with such instruments. The charges under this head should be less in future.

98. Every endeavour is being made to reduce all unnecessary expenditure. There is a certain amount of work to be done and it can be carried out either by employing a large number of poorly paid and indifferent surveyors to do it or by recruiting and training a better educated and better paid class and employing fewer of them. There can be no doubt that the second alternative is the one to be adopted because the pay of the surveyor, even a good one, is nothing as compared with the expenses of his squad of *khalasis*, his and their travelling charges, etc. The cost of training the Imperial and Provincial officers and civil and military surveyors during the year under report amounted to some R96,000; during 1907-08 it is estimated at a much higher figure, but after that year it will be considerably reduced as the parties will have nearly their full complement of trained men, and we shall only have to train sufficient to replace casualties.

99. The department has suffered most seriously of late years from the fact that there have never been sufficient Imperial officers to carry out the work, and consequently but few of them have had practical training in surveying before they were drafted to charges. Similarly the Provincial officers were required to

supervise the work of the ever increasing number of native surveyors and there was no time to train them and lastly the curtailment of the topographical work and expansion of cadastral and forest surveys on large scales conducted on very different principles, had reduced the number of men of all classes who had a thorough practical knowledge of surveying on the 1-inch and 2-inch scales to a very low ebb. Within the last two years however many of them have been carefully trained and it may be confidently expected that the trouble and expense involved will be amply repaid both in the quality and quantity of work which will be done.

100. In my next report I hope to be able to compare the outturn and cost of the department for the current year and that now under report and to show the estimated expenditure for the following year also; but this is difficult because the survey and financial years are different, the survey year ending on the 30th September and the financial year on the 31st March.

PART OF DISTRICT WEST KHÁNDESH. Season 1906–07 **BOMBAY** Magnetic Variation 0-50 East. No. 46 K/8

Published under the direction of Brevet Colonel S. G. Burrard, R.E., F.R.S., Officiating Surveyor General of India.

Scale 1 Inch = 4 Miles = 1:63,360

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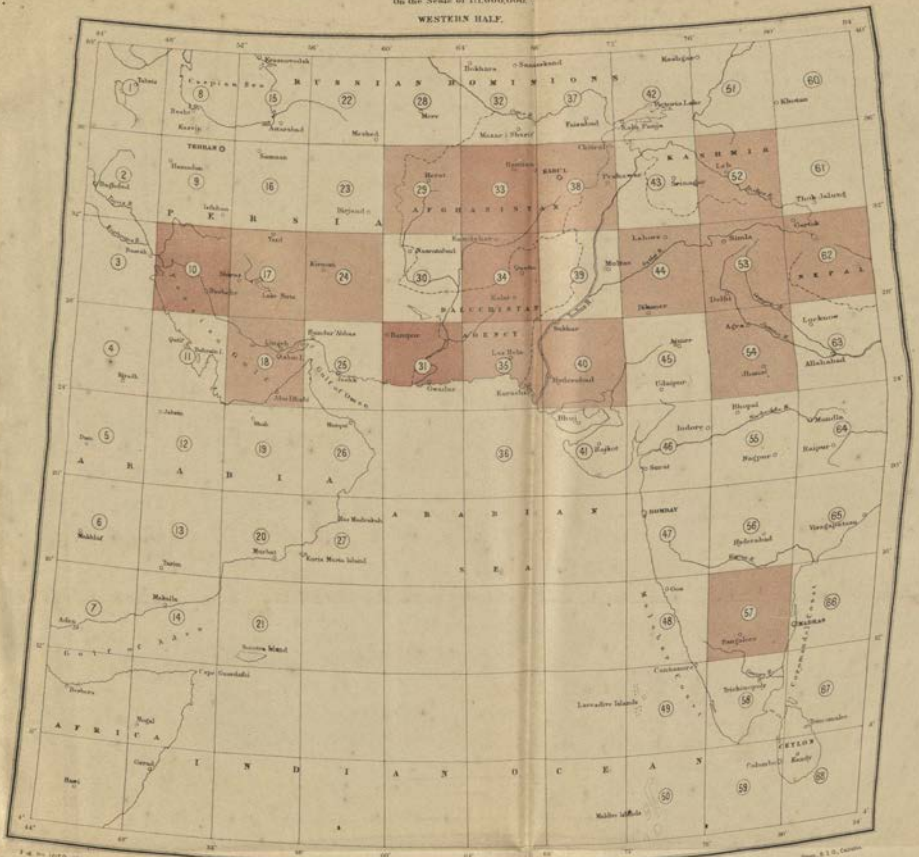
INDIA AND ADJACENT COUNTRIES SERIES.

On the Scale of 1:1,000,000.

WESTERN HALF.


RUSSIAN DOMINIONS
PERSIA
AFGHANISTAN
BALUCHISTAN
DESERT
ARABIA
ARABIAN SEA
INDIAN OCEAN
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KASHMIR
NEPAL
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Jidda
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Berber
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Suakin
Massowah
Gondar
Kaffa
Shoa
Abyssinia
Galla
Somali
Ogaden
Harar
Obock
Berbera
Zeila
Mukalla
Sur
Maskat
Sohar
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Bokhara
Samarcand

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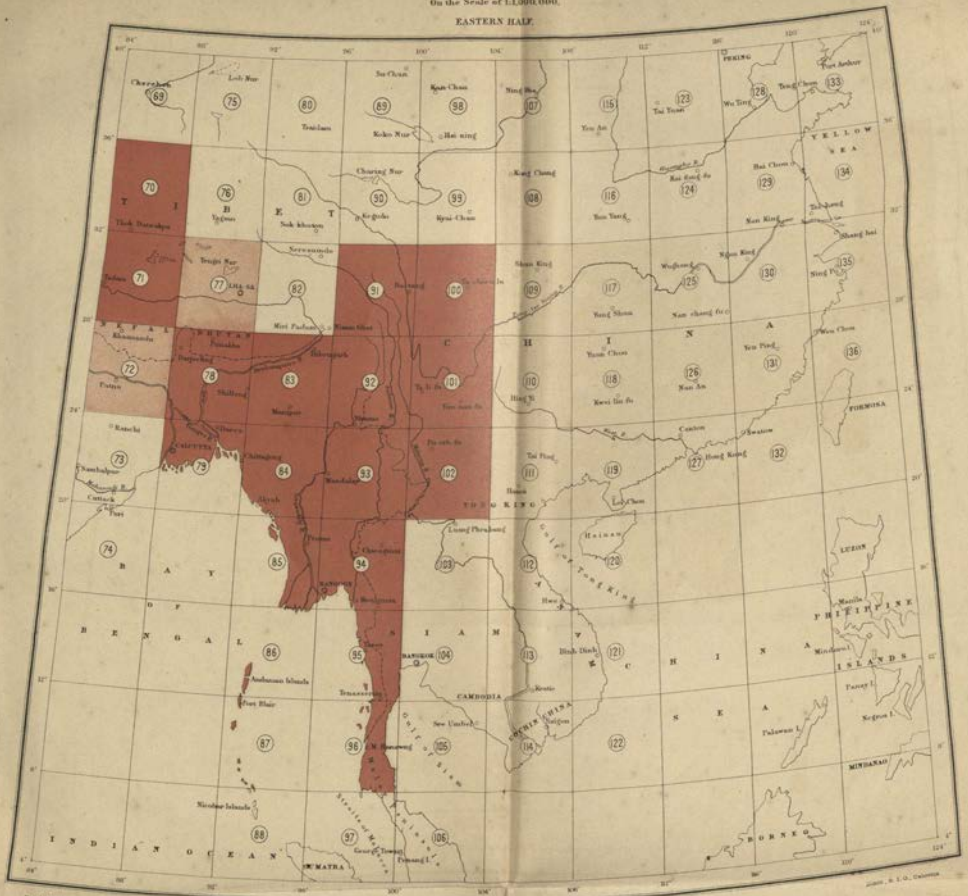
INDIA AND ADJACENT COUNTRIES SERIES.

On the Scale of 1:1,000,000.

EASTERN HALF.



Published under the direction of Br. Colonel S. G. Burrard, R.E., F.R.S., *Offg. Surveyor General of India*,

1906.

Scale of Miles.

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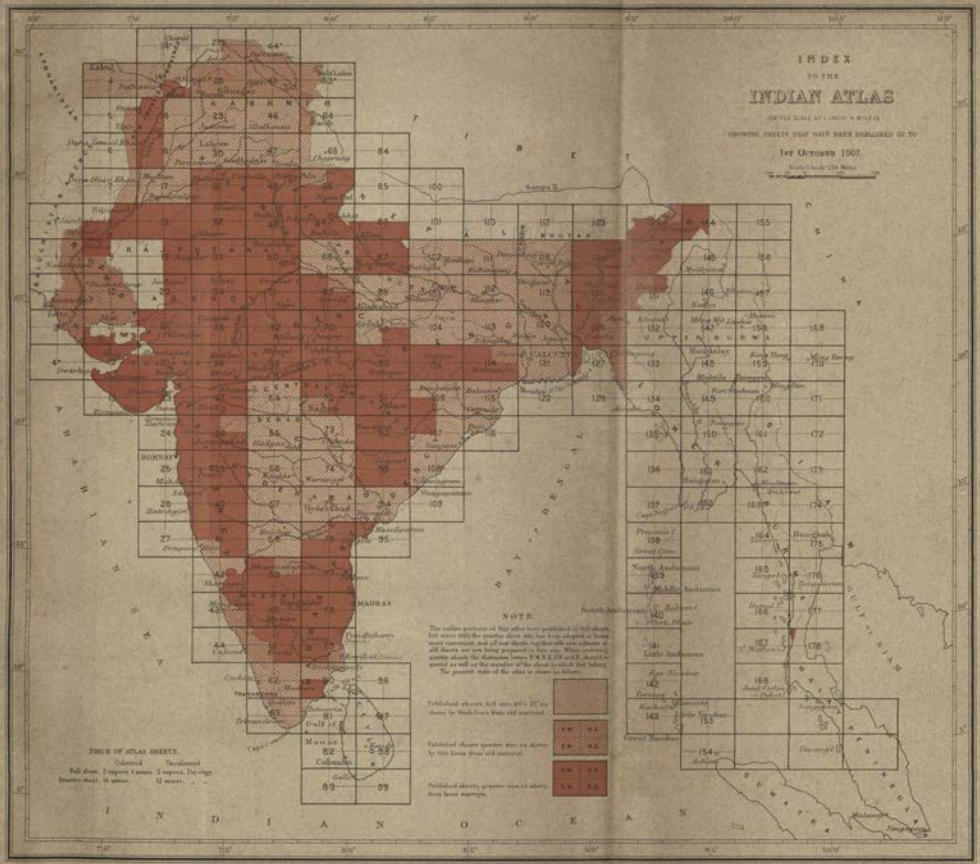
Sheets published.

" under publication.

" in hand.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TO THE
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ON THE SCALE OF 1 INCH = 4 MILES
SHOWING SHEETS THAT HAVE BEEN PUBLISHED UP TO
1st OCTOBER 1907.
Scale 1 inch (The Mile)
NOTE.
PRICE OF ATLAS SHEETS.
Coloured Uncoloured
Full sheet, 2 rupees 4 annas. 2 rupees. Per dozen
Quarter sheet, 14 annas. 12 annas. " "
INDIAN OCEAN
BAY OF BENGAL

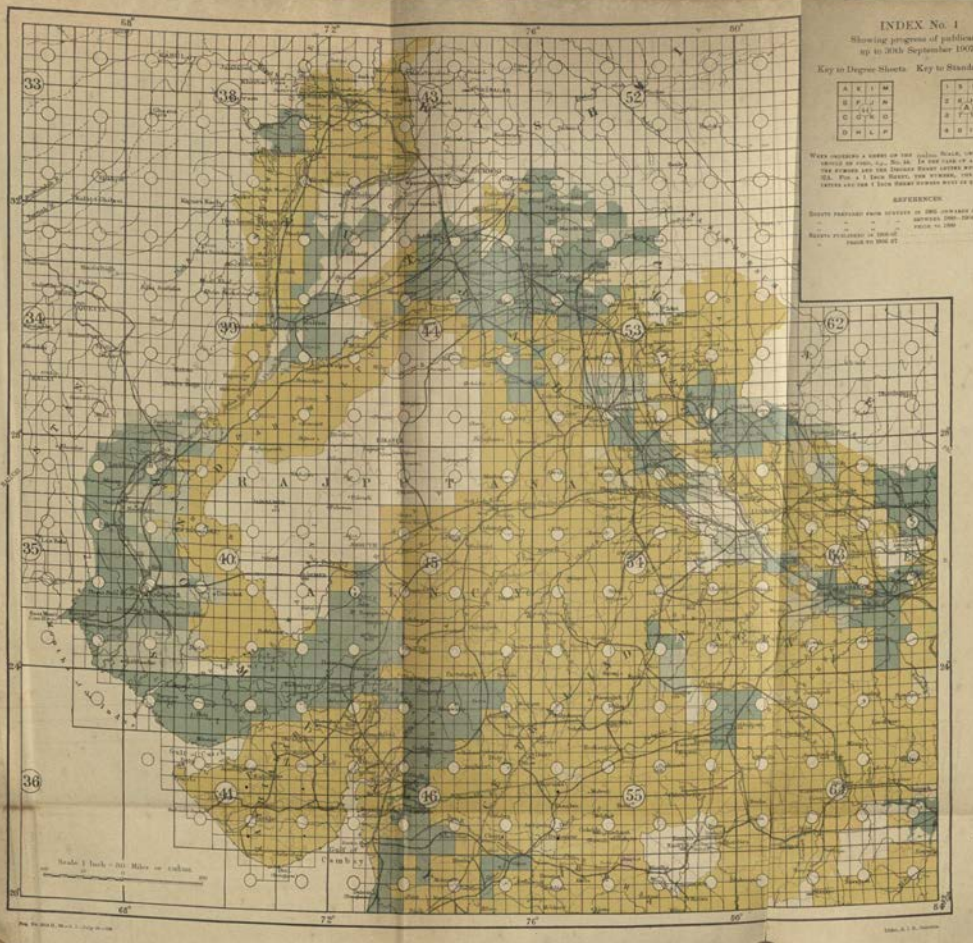
Published under the direction of MAJOR T. H. LONGE, R.E. (Officiating Surveyor General of India.

Registered at the Survey of India Office, Calcutta.

Litho. S. I. O., Calcutta.

July 1907.

Reg. No. 629-S. 07.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Key to Standard Sheets.
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A G I N C Y
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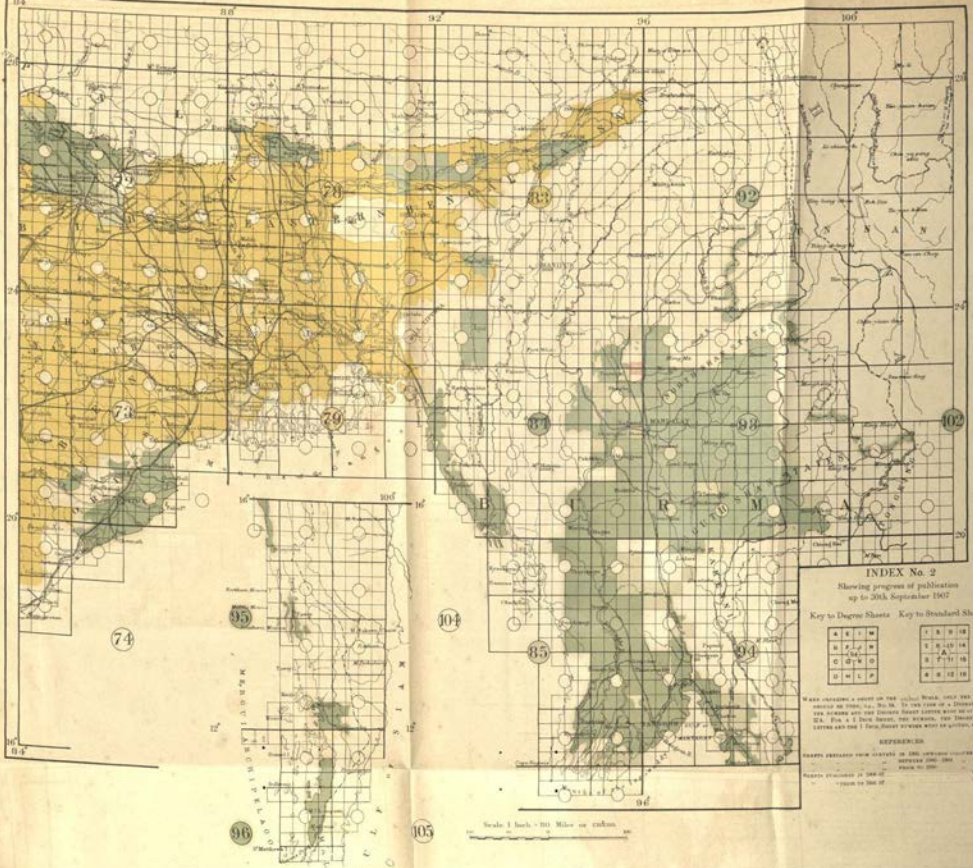
72°
76°
80°
33
38
43
52
34
39
44
53
62
35
40
45
54
63
36
41
46
55
64
Cambay


INDEX No. 2
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Key to Degree Sheets
Key to Standard Sheets
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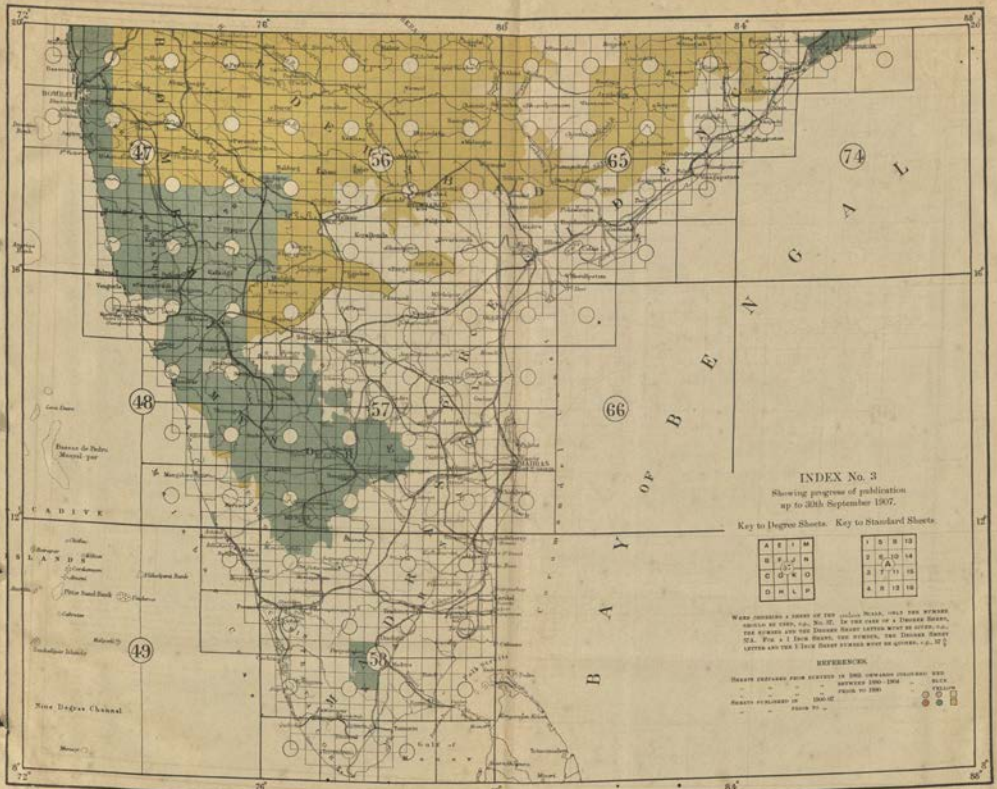
Scale 1 Inch = 10 Miles or 16Km.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CADIVE
ISLANDS
Nine Degree Channel
Gulf of Mannar
47
48
49
56
57
58
65
66
74
72°
76°
80°
84°
88°
20°
16°
12°
8°

PART II.

THE OPERATIONS OF FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 PARTY.

101. The party was under the charge of Captain C. M. Browne, D.S.O., R.E., throughout the year under report.

Personnel.

Imperial Officers:

Captain C. M. Browne, D.S.O., R.E., in charge.
Lieutenant E. B. Cardew, R.E., from 1st September 1907.

Provincial Officers:

Messrs. C. D. Simons, till the 18th November 1906, C. H. Tresham and Munshi Abdul Hai from the 16th September 1907. Messrs. V. D. B. Collins from the 3rd June 1907, V. P. Wainwright from the 16th May 1907, F. W. Smith from the 16th September 1907, and G. A. Norman from the 17th September 1907.

Subordinate Establishment:

6 Recorders, 1 Writer and 1 Hospital Assistant.

102. The programme of the party was to continue westwards the Kalát Longitudinal series from where it had been left off in season 1904-05 and the party assembled at Nushki by the 9th October. After spending some days in making the necessary arrangements for supplies, escorts, etc., the party marched along the Seistan trade route to Dalbandin, from whence the first station Pragi was reached on the 1st November.

103. After adjusting the instrument observations were commenced and were continued until the 16th March 1907, when the field work was closed with the approval of the Superintendent, Trigonometrical Surveys.

At Kisanen Chapper an Astronomical Azimuth was observed: while the observations were in progress here news was received that Mr. Simons was seriously ill, and Captain Browne had to leave at once for Merui. Mr. Simons died before he could arrive there and some days were necessarily spent in settling his accounts and re-arranging the squads, and it was the 26th November before observations could be recommenced. This sad event cast a gloom over the party, and his absence was badly felt.

Subsequently observations were continued without much interruption until Gat-i-Barot was left on the 4th January. The country then became more open and the dust-laden wind blew almost incessantly, causing great annoyance and frequently obscuring even the nearest objects.

104. Owing to the configuration of the country the triangulation west of the line Gharibo-Malik Shah was very difficult to carry out. Koh-i-Sultan with its group of high peaks rose alone to the west, north lay an enormous sandy desert stretching to the Helmand, while to the south a wide stony plain gradually sloped down to the Hamun-i-Mashkhel. In consequence a hexagon had to be employed of which one station, Kondi, had to be built in the open plain, and the others on low hills round the central station which was on the highest point of Koh-i-Sultan. The station in the plains gave a lot of trouble, when observed to from Malik Shah it was unsteady and a great number of observations (130) had to be taken to it to get a satisfactory value. But the worst was experienced when observations had to be taken from it, owing to mirage with its abnormal refraction.

105. The country in which the work lay is about as desolate and barren as a land can be. It is practically uninhabited except for a few nomad shepherds, and the residents in the thanas maintained along the Seistan trade route; but it is full of interest to the geologist and the surveyor.

At times during December, January and February the most bitter cold was experienced, not so much on account of the lowness of the temperature, which

was never as low as it is in the Quetta district, as from the wind which seems to get through everything.

After closing work at Miri Sultan on the 16th March the party left for Nushki, where it arrived on the 5th April. Captain Browne with Mr. Tresham proceeded in advance by rapid marches to the Kalát district to select the stations for the first figure of the proposed Toba series.

106. Owing to the great elevation of most of the stations of this new series, many of which are over 10,000 ft. high, and some over 11,000 ft., it will be impossible to carry on the work except in the summer or early autumn, so that in order to be able to start the observing next spring, Mr. Wainwright was sent on the 20th September 1907 to build the stations and to continue the reconnaissance into the Toba plateau.

107. Captain Browne, having entrained his party at Nushki for Dehra Dún, where it arrived on the 12th, proceeded to Quetta to make arrangements for the proposed programme for the principal triangulation in Baluchistan for next year, arriving in Dehra Dún on the 17th April.

108. Five Imperial Officers were attached to the party for instruction during the recess and the programme decided on was the re-observation of certain stations of the great arc, and the fixing of two new stations at Shorpur and Top-Tiba; also the observation of an Astronomical Azimuth at Banog. Owing to the interruption from haze the observations at Doiwalla and Shorpur were postponed as it is probable that further stations on the south side of the Siwaliks will be required. Field work was therefore closed on the 22nd of June.

109. In recess the computations of the season's work were completed. Orders were received to make arrangements for the re-starting of the Great Salween series in Burma, without stopping the work in Baluchistan, which was to include the reconnaissance of the Toba series, in addition to the work on the Kalát Longitudinal series. This necessitated the considerable strengthening of the party.

110. The health of the party was no worse than might have been expected from the character of the country in which it was working: beyond Nushki fresh vegetables were unobtainable, and the constant drinking of distilled water increased the difficulty of digestion. In consequence of this there were a great many cases (110) of, and 1 death from, scurvy.

111. A number of observations of magnetic declination were taken in Western Baluchistan along the trade route and on the Great Trigonometrical stations. The results were handed over to the officer in charge No. 26 Party for computation and incorporation in his report.

112. The party was inspected in recess by the Superintendent, Trigonometrical Surveys, on the 24th September.

SCIENTIFIC OPERATIONS.

GEODETIC.

ASTRONOMICAL LATITUDES.

NO. 22 PARTY.

113. This party was employed under Captain Cowie, R.E., on latitude operations in Kathiáwár and round the Gulf of Cambay. Observations were taken at twelve stations, including Dehra Dún.

Personnel.

Imperial Officer:

Captain H. M. Cowie, R.E., in charge.

114. The results of the season's work are given below :—

TABLE OF RESULTS OF SEASON'S WORK.

Name of Station.	Latitude.	Longitude.	Height above mean sea level.	Deflection of the plumb line. (O—C)
	° ′	° ′	Feet.	″
Dángarvádi H. S.	20 43	70 59	96	—8·52
Kunkaváv T. S.	21 39	70 59	591	—1·65
Dungarpur H. S.	22 48	71 2	404	—4·69
Chamárdi H. S.	21 49	71 58	42	—2·77
Ingrodi T. S.	22 57	71 51	118	—5·08
Páldi H. S.	22 54	72 34	208	—5·47
Ghoráráo H. S.	22 52	73 24	323	—3·12
Pávágad H. S.	22 28	73 33	2,721	—4·38
Sidhpur H. S.	22 4	73 31	169	—3·44
Álamvádi H. S.	21 35	73 33	848	—3·68
Tarbhán H. S.	21 1	73 6	140	—5·77

These values of O—C conform to the general character of the deflection of the plumb line in Rajputana and the west of peninsular India.

The results given by the observations in Kathiáwár show that there exists a source of attraction about Latitude 21° 30′, the relatively dense mass causing this attraction distributed here along an axis roughly south-west by west and north-east by east. As the central portion of the Kathiáwár peninsula is covered with a basalt overflow, the density of which is greater than the average surface density, it is probable that the local deflections of the plumb line are due to this basalt mass.

The results given by the observations at stations to the east of the Gulf of Cambay show that Thikri, Latitude 22° 2′, Longitude 75° 27′, in the Nerbudda valley, lies in a small tract of abnormal positive values of O—C, the deflection of the plumb line.

115. At the time of submission of this report, the reduction of the Dehra Dún observations had not been fully completed.

PENDULUM OPERATIONS.

No. 23 PARTY.

116. The work undertaken was the determination of the force of gravity at stations at the foot of the Himalayas, in and near the Siwaliks, and at a few stations belonging to or near the Great Arc including Nojli and Kaliána which were two of Captain Basevi's stations in 1865-66.

Personnel.

Imperial Officer:

Major G. P. Lenox Conyngham, R.E., in charge.

Provincial Officer:

Babu Hanuman Prasad.

117. The objects in view were to ascertain whether the deficiency in the force of gravity, which seems to be a peculiarity of submontane tracts, is of sensibly constant amount over considerable areas, or is subject to local variations: to

Programme of work.

examine some stations outside the Siwaliks at a place where the Siwaliks and Himalayas are distinctly separate, and to commence the search for the exact position of the crest of the hidden range, the existence of which was demonstrated by Colonel Burrard, R.E., F.R.S., in Professional Paper No. 5.

The stations.

118. The stations selected may be classified as follows:—

At the foot of the Himalayas	Rájpur
	Kálsi
In the Dún	Fatehpur
In the Siwaliks	Asárori
	Mohán
	Hardwar
Outside the Siwaliks	Roorkee
	Nojli
On the Great Arc	Kaliána
	Meerut
	Gesupur.

Observing Rooms.

119. At all these places observing rooms were obtained, in some cases good and in others only fair.

At Kaliána the observatory built by Sir G. Everest in 1836, and utilised on several subsequent occasions, was occupied. At Nojli the lower storey of the tower, which is the station of the Great Trigonometrical Survey, served as the observing room, but it was not very convenient, being too small and the temperature conditions in it not good. At most of the other stations Major Lenox Conyngham was indebted to officers of the Public Works Department or Military Works Service for the loan of inspection bungalows.

At Rájpur a good room in the premises of the Glass Factory was kindly lent, and in Meerut an excellent room in a private house was generously placed at the disposal of the party.

Temperature.

120. The alterations made since last field season in the attachment of the dummy pendulum, which carries the thermometer for determining the temperature of the pendulums, proved successful and a distinct increase in the accuracy of the results has been secured.

Pedestal.

121. An iron pedestal for the pendulum stand was taken into use this year, replacing the brick pillars which had hitherto been employed. This reduced the amount of preparation necessary at each station.

Clock Rate.

122. The star transits for the determination of clock rate were observed throughout by Babu Hanuman Prasad to the entire satisfaction of the officer in charge. The same instrument and method were used as during the season 1905-06.

Orographical correction.

123. Orographical corrections were required at six of the stations. It would perhaps have been legitimate to estimate several of them from general considerations, or from analogy with some of those stations for which the analysis has already been carried out. But as this could not be done for all it was thought better to perform the calculation in full in each case. The information gained will probably render it unnecessary to expend so much labour on the matter in future.

Results of the season's work.

124. The results of the observations are given in the table.

Station.	Latitude.	Height abve sea level.	Observed value of gravity = g.	g reduced to sea level = g_o.	Theoretical value at sea level = γ_o.	$g_o - \gamma_o$.
	° ′ ″	Feet.	Dynes.	Dynes.	Dynes.	Dynes.
Rájpur . .	30 24 12	3,321	979·002	979·205	979·330	—0·125
Kálsi . .	30 31 0	1,684	979·131	979·234	979·339	—0·105
Fatehpur . .	30 25 57	1,415	979·147	979·232	979·332	—0·100
Asárori . .	30 14 25	2,467	979·059	979·205	979·317	—0·112
Mohán . .	30 10 53	1,660	979·109	979·209	979·313	—0·104
Hardwar . .	29 56 29	949	979·122	979·179	979·294	—0·115
Roorkee . .	29 52 20	868	979·129	979·181	979·288	—0·107
Nojli . . .	29 53 28	879	979·143	979·194	979·290	—0·096
Kaliána . .	29 30 55	810	979·154	979·202	979·260	—0·058
Meerut . .	29 0 26	734	979·151	979·194	979·221	—0·027
Gesupur . .	28 33 2	691	979·125	979·166	979·186	—0·020

It is to be noticed that there is everywhere a deficiency in gravity, which is considerable near the hills and grows rapidly less as we move southwards.

It is also to be noticed that the defect is less at western stations than at similarly situated points further to the east. Thus at Kálsi we have a defect of 0·105 and at Rájpur one of 0·125; at Fatehpur one of 0·100 and at Dehra one of 0·123; at Mohán one of 0·104 and at Hardwar one of 0·115; at Nojli one of 0·096 and at Roorkee one of 0·107.

These amounts are all larger than that found at Kalka, where the situation is similar to that at Kálsi or at Rájpur, but much less than the defect at Pathánkot which is in a position comparable to that of a place half way between Nojli and Mohán. At Kalka the defect was 0·085 and at Pathánkot 0·179; at Siliguri, again, which may be compared with Roorkee, the defect was 0·137.

We have evidence therefore that at the base of the hills and to some distance from them there is always a defect in the force of gravity, which we may interpret as a deficiency of density in the earth's crust, but that the amount of this deficiency is by no means constant.

The observations of 1904-05 and of 1905-06 showed that as we recede from the hills the force of gravity increases with reference to the calculated value, and at a distance of about 130 miles from the foot of the hills the excess attains a maximum. The southernmost station of this season was only about 100 miles from the foot of the hills and at it gravity was still in defect.

It is important that the position of the line of maximum excess, and also the amount of the excess, be determined with considerable precision along the whole length of the Himalayas.

Dr. Hecker's Observations.

125. Professor Dr. Hecker, who made pendulum observations at Jalpaiguri in 1905 in conjunction with Major Lenox Conyngham, has furnished his results. His value for g at Jalpaiguri based on Potsdam is 979·624; that obtained by Major Lenox Conyngham through Kew and Dehra Dún is 979·622. The accordance is very satisfactory.

TIDAL AND LEVELLING OPERATIONS.

No. 25 PARTY.

Personnel.

Imperial Officer:

Mr. C. F. Erskine, in charge.

Provincial Officers:

Messrs. J. P. Barker, H. G. Shaw, E. H. Corridon, Munshi Syed Zille Hasnain, Mr. A. M. Talati, Mr. O. N. Pushong, Babu P. N. Sur and Mr. D. H. Luxa.

Subordinate Establishment:

1 Surveyor, 25 Computers, 2 Native Artificers and 4 Tidal Observatory Clerks.

126. Mr. C. F. Erskine held charge of the party throughout the year.

TIDAL OPERATIONS.

127. Observations were taken by means of self-registering tide-gauges during the year at the stations enumerated in the following list:—

	Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1	*Aden*	1879	Still working	27	
2	*Karachi*	1881	Working up to 6th June 1907.	26	Wrecked on 6th June 1907. Being re-erected.
3	*Bombay (Apollo Bandar)*	1878	Still working	29	
4	*Bombay (Prince's Dock)*	1888	„	19	Property of Port Trust.
5	*Madras*	1880 re-started 1895	1890 Still working	10 12	22
6	*Kidderpore*	1881	„	26	
7	*Rangoon*	1880	„	27	
8	*Port Blair*	1880	„	27	

128. In addition to the above, readings to tide-poles were taken at Bhávnagar, Chittagong, Akyab and Moulmein.

129. The 8 tidal observatories at work were inspected during the year; the registrations have been satisfactory at all of them, except at Karachi, where unfortunately a cyclone, which swept over the harbour on the 6th June, carried the cabin and all instruments and records therein located, bodily into the sea. Immediate steps were taken for the re-erection of the cabin and the necessary tidal instruments were promptly despatched from Dehra Dún. The Port Officer expects to have the cabin ready for the installation of the instruments and the resumption of observations in a short time. During the interruption, hourly readings to a tide-pole, during daylight, are being taken.

130. Owing to the contemplated enlargement of the Madras harbour, it will in all probability be necessary to remove the tidal observatory from its present position to some point on the new arm of the harbour which will project northwards. The exact position of the new observatory cannot be defined until the proposed new arm of the harbour has been completed and the present entrance to the harbour closed.

131. A tidal wave appeared in the Indian seas between the 4th and 6th January. The effect of this wave in raising the level of the water was depicted on the tidal diagrams at Port Blair, Madras, Bombay and Karachi. At Port Blair it was 5 inches, at Madras so small as to be reckoned insignificant, at Bombay it was 2 inches and at Karachi 3 inches.

132. In the following tables are given the annual and decadal percentages of the predicted time and height errors of high and low water at open coast and riverain stations:—

Percentage of Errors in Predicted Times and Heights at Open Coast Stations from Automatic Registrations.

Year.	Number of Stations.	In Time.		In Height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{12}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1897	8	71	75	96	97	97	97
1898	9	74	70	96	96	95	95
1899	9	74	66	95	95	93	92
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
1905	7	82	79	96	95	96	97
1906	6	85	81	96	97	94	95
Average of 10 years	8	76	71	95	95	95	94

Percentage of Errors in Predicted Times and Heights at Riverain Stations from Automatic Registrations.

Year.	Number of Stations.	In Time.		In Height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{12}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
1905	2	52	62	72	57	94	92
1906	2	59	53	74	64	92	95
Average of 10 years	2	56	60	73	60	92	91

133. The re-opening of the observatory at Moulmein was expected to have taken place early in this year, but owing to revision of plans and estimates requiring the official sanction of Government the erection had to be put off. Further

postponement of the work was necessitated by the advent of the monsoon; during the rains the state of the river due to floods, etc., is such that the construction of the observatory during this period would be slow and involve unwarrantable expenditure; the work had therefore to be held over until cessation of the rains. A set of the required instruments is ready for despatch at a moment's notice.

134. The establishment of tidal observatories at Koweit and Bahrein in the Persian Gulf has been proposed and approved by the Indian Government; the final decision of the Home Government is awaited. The needful preliminary measures involved in the undertaking have been attended to, so that there will be no delay in entering upon the project when final sanction shall have been obtained.

135. The idea of erecting a tidal observatory at Suakim in the Red Sea is still borne in mind, but no measures have been taken towards the furtherance of the scheme during the past year.

LEVELLING OPERATIONS.

136. There were three detachments engaged on the levelling operations of the past season.

137. No. 1 Detachment was employed principally on the revision of old levels along the G. I. P. Railway between Bombay and Madras *viâ* Gulbarga, Raichur, Gooty, Arkonam. The portion levelled over was from Bombay to Bársi Road, a distance of 236 miles. This detachment also connected standard bench-marks at Bombay, Poona, Kirkee and Ahmednagar and executed a short line of levels from Mussooree to Lal Tibba in Landour. The total outturn amounted to 257 miles of levelling. The field season for this detachment commenced on 13th October and ended on 30th May.

137. No. 2 Detachment executed the following lines of levels: Gwalior to Jhánsi, Segra Tower Station to Dera Ismail Khan, Ráwalpindi to Chach Base and thence to Pesháwar, and Saháranpur to Dehra Dún, the last being revision work. Eight new standard bench-marks were connected at the following places: Jhánsi, Delhi, Ambála, Ludhiána, Ferozepore, Jhelum, Attock and Pesháwar. The mileage totalled up to 284 miles. The field season began on 21st October and terminated on 16th May.

138. No. 3 Detachment was mainly employed on the line Bombay to Madras for purposes of revision, the portion revised being from Bársi Road to Kosgi, a length of 236 miles. Connection was made with the standard bench-marks at Sholapur and Devláli. In Mussooree a short line of levels was run to Banog H. S. The total outturn was 264 miles. This detachment's field operations lasted from 29th October to 4th June.

139. The new height of Raichur derived from the revised levelling from Bombay differs from that obtained from observations taken between 1878-81, by 1 foot 10 inches, the difference tending to cancel the error of 3 feet between the mean sea levels of Bombay and Madras as exhibited by the old levelling.

140. The new value for Raichur also diminishes the difference between the mean sea levels of Bombay and Kárwár, taking the route Bombay, Gulbarga, Raichur, Bellary, Hubli, Kárwár, by 9 inches, the difference by the old levelling being 11 inches.

141. The circuit Moorghai, Chach, Lahore, Ferozepore, Moorghai was completed last field season, the closing error being $7\frac{1}{2}$ inches.

142. The line Saháranpur to Dehra Dún was revised with the object of ascertaining whether any change had taken place in the heights of Dehra and Mussooree due to the earthquake of 4th April 1905. The result showed Mussooree unaltered and Dehra apparently raised by 5 inches.

143. Comparisons have been made between the results of levelling across water by three methods, namely: (1) the tide-pole or water-gauge method, (2) by vertical angles taken with a theodolite, (3) by observations with levels. A very good opportunity presented itself last field season of testing the accuracy of the different methods. The *locale* of these experiments was on the Indus

river at Darya Khân. Tide-pole and vertical angle observations were taken where the channel was narrow, about ½ mile in breadth; the actual levelling a few miles lower down, where islands had formed, affording the observers a convenient line for levelling across; the distances between staff and instrument not being more than 7 chains in any instance. The results by vertical angles are identical with those obtained by actual levelling, both differing from the result by the tide-pole method by 3 inches.

144. During the past year 19 standard bench-marks were erected, of which 14 have been connected; 27 are now in course of construction.

Up to date the number of standard bench-marks completed is 41; of these 36 have been connected, 5 remain to be levelled to. In all, 68 have been dealt with since 1903, when the scheme of erecting standard bench-marks all over India was initiated.

145. The number of bench-marks reported in the past year as destroyed is 205.

146. Binocular Precise Levels, imported from America, were for the first time used by Indian levellers last field season, with satisfactory results. Their employment involved certain deviations from the methods of levelling in vogue when observing with the cylindrical levels, the main departure being the reading of only one face of the staves on 3 wires of the instrument. The party has four of these levels, of which three were in use in the field.

147. The levelling operations to be performed during the coming field season are:—

For No. 1 Detachment: to level from Gooty to Madras, about 258 miles closing on the bed-plate of the tide-gauge at Madras, and to connect the standard bench-marks at Cuddapah and Madras.

No. 2 Detachment: to level from Ferozepore along the railway line, towards Ahmedabad as far as Bikanir, about 257 miles, and to connect the standard bench-marks at Bikanir, Multán and Dera Ismail Khan.

No. 3 Detachment: to connect the standard bench-mark at Raichur, to level from *Kosgi* to *Gooty*, about 68 miles; then to go on to Hyderabad (Deccan), connect the 3 standard bench-marks at Secunderabad and level towards Wardha (C. P.), partly by rail and partly by road, over a distance of about 200 miles.

REFRACTION OBSERVATIONS.

(AUTUMN 1906, SPRING 1907.)

148. Refraction observations were continued in October, November and December 1906, and March, April and May 1907.

The snow peaks, Bandarpunch 20,720 feet, Srikanta 20,120 feet, Jaonli 21,760 feet, and Kedarnath 22,770 feet, were observed from Mussooree 6,931 feet, Nag-Tibba H. S. 9,915 feet (spring 1907 only), and two stations at Nojli, one at ground level 888 feet, and the other at top of Nojli T. S. 938 feet (spring 1907 only).

Reciprocal vertical angles were taken between Mussooree-Dehra, Mussooree-Nojli (Shaw's) Mussooree-Nojli T. S. (spring 1907 only) and Mussooree-Nag-Tibba H. S. (spring 1907 only).

The spirit-levelled heights being accepted as correct, the errors due mainly to refraction are—

Between Mussooree-Dehra, 3 feet for both seasons.

Between Mussooree-Nojli (Shaw's), 2 feet for autumn 1906, and 7 feet for spring 1907.

This difference in the heights for autumn and spring is chiefly due to the changes in the angles taken at Mussooree for these seasons.

Between Mussooree-Nojli T. S., 10 feet for spring 1907.

The results of the observations are as follows:—

(i) At Mussooree. No change in the difference of height of Dehra and Nag-Tibba H. S. for the years 1905-06 and 1906-07.

(ii) As in the year 1905-06, the deduced heights of snow peaks and the two stations at Nojli were again lower in spring 1907 than in autumn 1906; Bandarpunch being 11 feet lower, Srikanta 8 feet, Jaonli 5 feet, and Kedarnath 12 feet, Nojli T. S. about 12 feet, and Nojli (Shaw's) 9 feet.

(iii) It follows from the preceding paragraph that for the past two years refraction has varied between autumn and spring.

(iv) The difference in the heights of snow peaks between autumn 1905 and autumn 1906, spring 1906 and spring 1907 were, respectively, as follows:—

	Autumn.	Spring.
Bandarpunch	7 feet	0 foot
Srikanta	5 feet	13 feet
Jaonli	8 feet	10 feet
Kedarnath	16 feet	No observations in Spring 1906.

The autumn heights 1906, being lower, and the spring height 1907, higher.

(v) During 1906-07, it sometimes happened that the angles of depression to the two stations at Nojli were less at 10 A.M. than at 8 A.M., varying from 2 seconds to 10 seconds, thus the heights of these two stations at Nojli would have been higher at 10 A.M. than at 8 A.M. *No such irregularity occurred in 1905-06.*

At Nojli. - The changes in the angles of elevation at minimum to Mussooree have been very small during the years 1905-06 and 1906-07, and consequently refraction has been steady during these years for observations to Mussooree.

(i) The heights of the snow peaks were lower in spring 1907 than in autumn 1906, Bandarpunch being 28 feet lower, Jaonli 4 feet, and Kedarnath 27 feet.

For want of observations no comparisons can be made in the difference of height of snow peaks between the years 1905-06 and 1906-07.

At Nag-Tibba H. S.—The heights of snow peaks in spring 1907 were higher than in spring 1906, Bandarpunch being 8 feet higher, Srikanta 14 feet and Jaonli 18 feet.

MAGNETIC OPERATIONS.

No. 26 PARTY.

149. *Work of the field detachments.*—During the year under report field operations were carried on by four detachments: two were employed in Burma, one in Assam, Manipur and Lushai, and the fourth in Chota Nagpur, the Agency tracts of Vizagapatam and the Tributary States of Orissa.

Personnel.

Imperial Officers:

Captain R. H. Thomas, R.E., in charge.
Lieutenant H. J. Couchman, R.E.

Provincial Officers:

Messrs. E. C. J. Bond, and H. P. D. Morton, Babu R. P. Ray, Mr. E. A. Meyer, and Babu N. R. Mazumdar.

Subordinate Establishment:

14 Observers, Recorders, Computers, and 2 Surveyors and 1 Writer.

In addition, observations were made at eight stations grouped round Buxar to investigate the abnormal value of declination found in 1903-04.

The total outturn of new stations was 152. The field season commenced on the 19th October 1906 and the party proceeded to recess quarters on 1st May 1907.

150. *Work of the Imperial Officers.*—A second Imperial Officer, Lieutenant H. J. Couchman, R.E., was posted to the party in September 1906; with his assistance all the repeat stations, 22 in number, were visited. The officer in charge inspected the observatories at Dehra Dún, Barrackpore, Kodaikanal and Toungoo, and carried out comparative observations at each to determine the differences from the survey standard.

Vertical force magnetographs were erected at Barrackpore, Kodaikanal and Toungoo observatories and satisfactory adjustments of the temperature co-efficients made.

Vertical force magnetographs are now working at all the observatories and have continued to give good results except at Kodaikanal. At this observatory, however, the magnet which had proved unsatisfactory at Dehra Dún has been only temporarily mounted, pending the arrival of a new magnet which will be installed in December next; it seems probable that the agate knife edge of the present magnet is defective. The officer in charge also installed earth inductors of the Schulze pattern in each observatory to replace the dip circles; the inductors were previously compared with one another and gave extraordinarily accordant results, the greatest difference in dip between any pair, by simultaneous observations, being $\pm 0'.2$.

The temperature co-efficient of the Toungoo H. F. magnetograph was also satisfactorily determined, the value found being -7.4γ *per* 1°F.

151. *Total work to date.*—The total number of stations occupied to date is 1,110 with 22 repeat stations.

In addition the Magnetic Survey is indebted to Captain C. M. Browne, D.S.O., R.E., who observed the magnetic declination at 25 stations on the Seistan trade route with equipment supplied by this party. Included in these observations are the largest values of east declination observed during the present survey, *viz.*, 5°E at Malikshah in latitude 29° 1′ 42″, longitude 62° 58′ 57″, and 7° 43′E at Gharibo in latitude 29° 20′ 30″, longitude 62° 58′ 30″.

152. *Work during recess.*—During the recess season the computations of the field work have been completed, while the reduction and tabulation of the base station results are also practically finished. The field instruments were all compared with the survey standards at the beginning and end of the field season. Further investigations have been made with regard to the correction of the field observations for diurnal variation. From the results from the four base stations, Colaba, Dehra Dún, Barrackpore and Kodaikanal, simple formulæ connecting change in diurnal variation with change in latitude had already been established, by which using the results of two base stations the diurnal variation at any third station may be determined: in the present investigation the results of Toungoo observatory were included to determine whether the formulæ would still hold good within the wider limits of longitude.

The results were quite satisfactory, and the formulæ have now been established for the limits of the magnetic survey of India.

It was again noticed that the results when using the Kodaikanal H. F. values were never so satisfactory as when this observatory was excluded from the discussion; in the reduction this observatory will not be used, if the curves from two other base stations are available. The discordance probably arises from the fact of this observatory being situated on rock which is distinctly magnetic. Investigations into the variation of disturbances from point to point are in progress at the present time on lines suggested by Sir A. Rücker, F.R.S.; these investigations which require a knowledge of the variations of the vertical component of the earth's field could not be commenced until results from the vertical force magnetographs were available and the installation of these instruments was completed only in March last.

153. *The base stations.*—With the exception of the Kodaikanal vertical force instrument, the base station magnetographs continued to work satisfactorily throughout the year.

With the compensation devices provided, the temperature co-efficients of the vertical force instruments were reduced to the figures noted below:—

Dehra Dún	-5.2γ	*per* 1°F.
Barrackpore	$+3.9\gamma$	
Toungoo	-2.1γ	
Kodaikanal	$+3.4\gamma$	

The earth inductor No. 30 by Schulze has replaced dip circle No. 44 as the survey standard, the difference between their indications being—

Inductor 30 − Dip Circle 44 = +0′.8.

154. *The mean values of magnetic elements at observatories for 1906.*—The mean values of the magnetic elements at the observatories for 1906 are as follows:—

Dehra Dún	Declination	2° 39.′2 E.
	H. F.	.33365 C.G.S.
	Dip	43° 29.′8.
Barrackpore	Declination	1° 14.′1 E.
	H. F.	.37259 C.G.S.
	Dip	30° 26.′4.
Kodaikanal	Declination	0° 36.′3 W.
	H. F	.37425 C.G.S.
	Dip	3° 21.′1.
Toungoo	Declination	0° 43.′6 E.
	H. F.	.38715 C.G.S.
	Dip	22° 59.′2.

155. *Work projected for 1907-08.*—During the next field season (the last of the preliminary survey) three detachments will be employed in Burma and its administered tracts, while a fourth will observe in India in such tracts as remain.

It is estimated that 110 new stations will be established which with previous seasons' work will give a total of 1,220.

The extension of the survey into the Himalayas which is most desirable must be deferred until the detailed survey is begun.

It is hoped that the reduction of the field work may be so far advanced as to indicate, before the field season 1908-09, the disturbed districts in which detailed observations should be taken; but this reduction cannot be properly effected until satisfactory formulæ, empirical or theoretical, have been found for the variation from point to point of disturbances, and sufficient data accumulated for the investigation of the proper values to assign to the secular change in the districts intervening between the base stations: should then, as is probable, this reduction not be sufficiently advanced, the detailed survey will be begun by the examination of the northern edge of the Deccan trap which has already been asked for by the Geological Survey.

156. A table showing the approximate preliminary values (uncorrected) at the field and repeat stations in 1906-07 is appended, together with a reference index map showing all the stations of observation to date.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1906-07.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
959	Gahmar	13	25 29 0	83 48 10	36 6	E 1 42	0·3603	
960	Dumraon	14	25 34 40	84 7 30	36 1	„ 0 19	0·3547	
961	Mandalay	1	21 59 50	96 6 30	29 10	„ 0 51	0·3801	
962	Wunbye	2	21 56 10	95 32 20	29 6	„ 0 55	0·3794	
963	Alôn	3	22 13 30	95 4 50	29 35	„ 1 4	0·3792	
964	Maymyo	4	22 2 20	96 28 0	29 20	„ 0 54	0·3787	
965	Gokteik Viaduct	5	22 20 10	96 51 30	29 59	„ 0 50	0·3787	
966	Hsipaw	1	22 36 40	97 17 50	30 33	„ 0 54	0·3777	
967	Manpwe	2	22 50 40	97 35 30	30 58	„ 0 57	0·3766	
968	Paukkan	6	22 14 10	95 52 10	29 44	„ 1 2	0·3785	
969	Shwèbo	7	22 35 0	95 41 50	30 22	„ 0 57	0·3780	
970	Kanbalu	1	23 13 10	95 32 40	31 47	„ 0 58	0·3748	
971	Kawlin	2	23 47 30	95 41 10	32 39	„ 0 42	0·3747	
972	Naba	3	24 15 0	96 11 10	33 37	„ 0 57	0·3727	
973	Mohnyin	4	24 46 30	96 21 20	34 52	„ 0 7	0·3720	
974	Taungni	1	25 10 20	96 44 20	36 6	W 0 21	0·3707	
975	Myitkyina	1	25 23 20	97 24 10	36 7	E 1 43	0·3619	
976	Sinbo	1	24 46 40	97 2 50	34 56	„ 1 31	0·3703	
977	Bhamo	2	24 15 30	97 13 10	33 42	„ 1 4	0·3731	
978	Sikaw	3	23 50 0	97 4 0	32 50	„ 1 11	0·3734	
979	Namhkam	4	23 50 0	97 40 10	32 52	„ 0 54	0·3740	
980	Hsenwi (Theinui)	5	23 17 40	97 57 10	31 56	„ 0 57	0·3753	
981	Mantôn	6	23 15 0	97 7 0	31 47	„ 0 51	0·3758	
982	Mogôk	8	22 56 0	96 31 20	30 59	„ 0 58	0·3776	
983	Wainglon	5	23 27 50	96 36 30	32 15	„ 1 18	0·3727	
984	Tagaung	6	23 30 20	96 0 50	32 25	„ 1 9	0·3738	
985	Thabeikkyin	9	22 50 50	95 58 20	31 6	„ 1 1	0·3765	
986	Sin-gu or Nga-sin-gu.	10	22 32 50	95 59 30	30 36	„ 1 11	0·3784	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1906-07—contd.

Serial No.	Name of station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
987	Yeshin	7	23 43 10	95 7 20	32 42	E 0 56	0·3736	
988	Manyu	8	24 19 20	95 33 40	33 35	„ 1 13	0·3736	
989	Nánantôn	9	24 45 30	95 40 30	34 39	„ 1 0	0·3702	
990	Homalin	1	24 51 50	95 54 30	35 0	„ 1 10	0·3693	
991	Paungbyin	2	24 16 0	94 48 20	23 47	„ 1 8	0·3708	
992	Kindat	3	23 44 10	94 26 0	32 43	„ 1 10	0·3730	
993	Kaléwa	4	23 11 20	94 18 20	31 36	„ 1 2	0·3756	
994	Peginma	1	22 43 50	94 42 30	30 41	„ 1 3	0·3769	
995	Gházipur	15	25 33 50	83 33 20	...	„ 1 37	0·3600	Dip not observed.
996	Zahúrábád	16	25 44 40	83 43 30	36 11	„ 1 31	0·3573	
997	Ballia	17	25 45 10	84 9 10	36 42	„ 1 10	0·3550	
998	Dighwára	10	25 44 30	85 0 40	36 5	„ 1 22	0·3590	
999	Ekma	18	25 58 10	84 32 10	37 22	„ 1 5	0·3492	
1000	Ránisankail	10	25 54 10	88 15 10	36 29	„ 1 32	0·3600	
1001	Taria	11	26 15 40	88 23 40	36 49	„ 1 33	0·3617	
1002	Charpanguri	9	26 33 0	90 8 10	37 51	„ 1 30	0·3588	
1003	Bijni	10	26 28 50	90 42 10	37 25	„ 1 24	0·3628	
1004	Patacharkuchi	10	26 30 40	91 14 10	37 49	„ 2 12	0·3571	
1005	Jia Bor	11	26 43 30	91 42 30	38 3	„ 1 38	0·3603	
1006	O'událgiri	12	26 45 50	92 6 50	38 8	„ 1 29	0·3598	
1007	Mokersá	13	25 31 10	91 25 0	35 10	„ 1 9	0·3633	
1008	Nongshobar	11	25 32 10	90 52 50	35 31	„ 1 38	0·3674	
1009	Rongrengiri	12	25 33 0	90 33 20	35 40	„ 1 9	0·3657	
1010	Damalgiri	13	25 31 40	90 6 50	36 9	„ 2 19	0·3654	
1011	Nálítábári	14	25 5 10	90 11 10	34 39	„ 0 55	0·3667	
1012	Asma	11	24 54 10	90 53 20	34 41	„ 1 16	0·3671	
1013	Ajmiriganj or Abidábád.	6	24 33 50	91 14 10	34 5	„ 1 16	0·3691	
1014	Sunámganj	14	25 4 10	91 23 30	34 55	„ 1 23	0·3676	
1015	Sylhet	7	24 53 0	91 52 0	34 40	„ 1 17	0·3678	
1016	Mokokchang	8	20 19 40	94 31 50	37 31	„ 1 11	0·3639	
1017	Wokhá	9	26 5 40	94 15 40	36 59	„ 1 11	0·3656	
1018	Kohímá	10	25 40 10	94 6 40	36 12	„ 1 15	0·3656	
1019	Karong	11	25 18 40	94 2 30	35 32	„ 1 9	0·3670	
1020	Manipur	5	24 48 30	93 56 30	34 31	„ 1 4	0·3697	
1021	Lengbu	6	24 44 40	93 24 10	34 27	„ 1 8	0·3698	
1022	Kolosib	8	24 15 20	92 42 10	33 29	„ 1 12	0·3714	
1023	Aijal	9	23 43 30	92 43 10	32 27	„ 1 6	0·3730	
1024	Tenzoil	10	23 18 20	92 47 10	31 44	„ 1 7	0·3734	
1025	Lungleh	2	22 53 40	92 44 50	30 56	„ 1 5	0·3753	
1026	Rángámati	3	22 38 10	92 11 50	30 24	„ 1 4	0·3762	
1027	Bhatiyari	4	22 26 10	91 45 0	29 56	„ 1 0	0·3766	
1028	Mirsarai	5	22 46 40	91 37 50	30 38	„ 1 4	0·3753	
1029	Silli	13	23 21 10	85 50 40	32 1	„ 1 14	0·3673	
1030	Ránchi	14	23 22 40	85 19 30	31 52	„ 1 25	0·3667	
1031	Jariagarh	15	23 1 40	85 1 0	31 3	„ 1 0	0·3689	
1032	Kolebira	10	22 42 20	84 42 0	30 30	„ 1 6	0·3714	
1033	Chakarkend	11	21 18 10	83 30 30	27 48	„ 0 51	0·3725	
1034	Pátna	10	20 42 20	83 8 20	26 14	E 0 44	0·3759	
1035	Khariár	10	20 17 40	82 46 0	25 35	„ 0 23	0·3758	
1036	Nawarapara	11	20 48 40	82 31 50	26 54	„ 0 38	0·3725	
1037	Saraipali	12	21 18 20	83 0 30	27 52	„ 1 2	0·3725	
1038	Pithora	14	21 15 20	82 31 10	27 32	„ 0 49	0·3712	
1039	Tumgaon	15	21 11 40	82 7 20	27 30	„ 0 46	0·3722	
1040	Chimúr	11	20 29 0	79 22 10	25 46	„ 0 43	0·3710	
1041	Garhchiroli	12	20 11 0	80 0 40	25 17	„ 0 48	0·3736	
1042	Jaroundi	13	19 59 40	80 26 20	25 0	„ 0 39	0·3739	
1043	Parlákot	14	19 47 0	80 41 10	24 29	„ 0 35	0·3750	
1044	Koilibeda	15	19 57 40	80 59 0	24 40	„ 0 36	0·3748	
1045	Narainpur	12	19 43 10	81 14 50	24 5	„ 0 44	0·3752	
1046	Kondagaon	13	19 35 10	81 40 10	24 5	„ 0 31	0·3768	
1047	Kilepal	10	18 58 40	81 36 40	23 4	„ 0 29	0·3765	
1048	Barsur	14	19 8 10	81 23 20	23 19	„ 0 23	0·3760	
1049	Byramgarh	15	19 0 30	81 2 40	22 56	„ 0 24	0·3774	
1050	Vijapur	14	18 47 20	80 49 0	22 15	„ 0 23	0·3789	
1051	Pothikál	15	18 32 30	80 54 0	22 15	„ 0 19	0·3754	
1052	Chintulnár	11	18 20 50	81 11 10	21 41	„ 0 34	0·3793	
1053	Madder	16	18 46 20	80 33 10	23 6	„ 0 37	0·3737	
1054	Matimirka	17	18 59 30	80 16 50	23 1	„ 0 32	0·3746	
1055	Kumargura	16	19 26 30	80 32 30	23 38	„ 0 37	0·3771	
1056	Ahiri	17	19 24 40	79 59 50	23 54	„ 0 38	0·3749	
1057	Ghot	18	19 49 0	79 59 20	24 40	„ 0 32	0·3737	
1058	Kondasantha	12	17 46 0	82 33 40	19 56	„ 0 51	0·3816	
1059	Parlakimedi	6	18 47 10	84 5 0	22 27	„ 0 25	0·3803	
1060	Jagganathpuram.	11	19 1 50	83 46 30	22 57	„ 0 29	0·3794	
1061	Sirgudi	12	19 25 20	83 49 0	23 43	„ 0 30	0·3785	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1906-07—contd.

Serial No.	Name of station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
1062	Govindapur	20/24 13	19 29 50	84 25 20	23 54	E 0 40	0·3789	
1063	Ghúsari	20/24 19	25 22 30	84 9 10	35 37	„ 1 0	0·3653	
1064	Arrah	„ 20	25 33 0	84 40 20	35 46	„ 1 30	0·3602	
1065	Palôn	18/26 1	17 26 20	95 56 0	19 41	„ 0 39	0·3900	
1066	Minhla	„ 2	17 58 30	95 42 20	20 52	„ 0 39	0·3890	
1067	Paungdé	„ 3	18 29 50	95 29 50	22 1	„ 0 41	0·3882	
1068	Prome	„ 4	18 49 40	95 13 20	22 41	„ 0 39	0·3874	
1069	Henzada Shore	„ 5	17 38 30	95 29 10	20 14	„ 0 43	0·3893	
1070	Athôk	„ 6	17 12 10	95 5 0	19 4	„ 0 41	0·3904	
1071	Bassein	16/25 1	16 46 20	94 44 30	18 7	„ 0 35	0·3909	
1072	Pegu	17/25 7	17 20 30	96 28 40	19 32	„ 0 47	0·3903	
1073	Pyuntaza	„ 8	17 53 0	96 43 20	20 52	„ 0 29	0·3884	
1074	Nyaungbintha	„ 9	18 24 20	96 27 20	22 1	„ 0 41	0·3873	
1075	Myohla	20/26 1	19 24 40	96 16 10	24 5	„ 0 49	0·3870	
1076	Pyôkkwe	„ 2	19 57 10	96 13 30	25 19	„ 0 46	0·3846	
1077	Shweda	„ 3	20 31 10	96 4 50	26 18	„ 0 54	0·3837	
1078	Thédaw	22/24 11	21 5 10	96 3 50	27 28	„ 0 48	0·3818	
1079	Kyauksé	„ 12	21 36 30	96 8 0	28 30	„ 0 47	0·3799	
1080	Mahlaing	„ 13	21 5 40	95 38 40	27 24	„ 0 52	0·3816	
1081	Myingyan	„ 14	21 28 30	95 23 40	28 11	„ 0 55	9·3806	
1082	Pakôkku	„ 15	21 20 0	95 5 30	28 4	„ 0 53	0·3799	
1083	Sabè	22/24 2	21 27 20	94 35 0	28 22	„ 0 52	0·3802	
1084	Pasôk	„ 3	21 23 0	94 11 0	28 3	„ 0 53	0·3799	
1085	Shwegôndaing	„ 4	21 49 10	94 6 30	28 59	„ 0 56	0·3783	
1086	Thitkyidaing	„ 5	22 1 20	94 32 10	29 15	„ 0 55	0·3784	
1087	Salingyi	23/24 16	21 58 30	95 4 40	28 30	„ 0 43	0·3818	
1088	Seikpyu	20/24 1	20 54 20	94 47 30	27 0	„ 0 48	0·3820	
1089	Kyaukyè	„ 2	20 34 40	94 48 30	26 22	„ 0 46	0·3826	
1090	Minbu	„ 3	20 10 0	94 53 20	25 31	„ 0 43	0·3837	
1091	Sinbaungwè	20/24 4	19 43 0	95 9 30	24 31	„ 0 43	0·3850	
1092	Thayetmyo	„ 5	19 19 30	95 11 10	23 45	„ 0 40	0·3859	
1093	Mindôn	20/26 4	19 21 10	94 44 10	24 0	„ 0 40	0·3857	
1094	Myothit	„ 5	19 45 20	94 38 10	24 41	„ 0 45	0·3841	
1095	Ngapè	„ 6	20 4 50	94 28 0	25 29	„ 0 42	0·3837	
1096	Sidôktaya	„ 7	20 25 50	94 14 0	26 10	„ 0 45	0·3824	
1097	Taukôk	„ 8	20 43 30	94 8 10	26 45	„ 0 50	0·3818	
1098	Kyindwé	„ 9	20 58 10	93 50 10	27 5	„ 1 0	0·3806	
1099	Thônlábyi	23/24 6	21 4 20	94 16 10	27 26	„ 0 50	0·3811	
1100	Chaunggya	20/26 6	20 44 0	95 13 30	26 49	„ 0 37	0·3818	
1101	Myindègyi	„ 7	20 26 30	95 36 30	26 0	„ 0 49	0·3837	
1102	Taungdwingyi	„ 8	20 0 0	95 32 50	25 13	„ 0 40	0·3846	
1103	Nget-pyaw-gyin	„ 9	19 34 20	95 39 20	24 17	„ 0 45	0·3860	
1104	Taunglè	18/26 10	18 53 30	95 40 20	22 46	„ 0 44	0·3872	
1105	Thamaing	16/26 1	16 51 50	96 7 0	18 27	„ 0 37	0·3911	
1106	Myohaung	19/26 10	20 35 20	93 11 20	26 22	„ 0 53	0·3816	
1107	Myebôn	„ 11	20 4 0	93 22 20	25 18	„ 0 43	0·3835	
1108	Rathedaung	20/24 1	20 29 10	92 45 10	26 3	„ 0 48	0·3822	
1109	Maungdaw	„ 2	20 49 50	92 21 40	26 50	„ 0 53	0·8310	
1110	Chakiria	23/24 6	21 46 0	92 5 50	28 41	„ 0 55	0·3785	
	Devláli		19 53 10	73 48 50	24 57	„ 0 12	0·3639	
1111	Nushki No. 1		29 33 10	66 1 0		„ 2 17		Declination only observed.
1112	Do. „ 2		29 32 0	66 0 40		„ 2 15		Ditto.
1113	Khuchaki		29 4 20	65 29 50		„ 2 27		Ditto.
1114	Padag No. 1		29 1 20	65 18 10		„ 2 57		
1115	Do. „ 2		29 1 30	65 17 30		„ 3 12		Ditto.
1116	Chahar Sar		28 57 0	65 0 10		„ 1 58		Ditto.
1117	Yadgar		28 57 30	64 56 0		„ 2 7		Ditto.
1118	Karodak		28 57 10	64 40 50		„ 2 32		Ditto.
1119	Dalbandin No. 1		28 54 10	64 25 30		„ 2 34		Ditto.
1120	Do. „ 2		28 54 30	64 25 40		„ 2 32		Ditto.
1121	Kisanen Chapper		29 4 0	64 22 40		„ 2 38		Ditto.
1122	Malik Siah Koh		29 12 20	63 55 0		„ 2 35		Ditto.
1123	Malik Teznan H.S.		29 24 40	63 40 50		„ 1 47		Ditto.
1124	Gat-i-Barot		28 57 10	63 35 10		„ 2 30		Ditto.
1125	Gharibo . I		29 20 30	62 58 30		„ 7 43		Ditto.
1126	Do. . II		29 20 10	62 58 10		„ 3 1		Ditto.
1127	Do. . III		29 19 30	62 58 0		„ 3 51		Ditto.
1128	Malik Shah		29 1 40	62 59 0		„ 4 58		Ditto.
1129	Kondi . I		28 50 20	62 36 0		„ 2 45		Ditto.
1130	Do. . II		28 49 40	62 35 40		„ 2 40		Ditto.
1131	Tuzgi . H.S.		28 53 10	62 15 0		„ 2 50		Ditto.
1132	Shuri . H.S.		29 11 0	62 29 50		„ 2 38		Ditto.
1133	Nil Dik		29 15 40	62 42 20		„ 2 55		Ditto.
1134	Miri Sultan H.S.		29 7 10	62 48 20		„ 2 38		Ditto.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1906-07—concld.

Repeat stations.

Serial No.	Name of station.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Forces.	Remarks.
		° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
I	Udaipur	24 35 33	73 41 57	33 43	E 1 25	0·3533	
II	Karachi	24 49 50	67 2 2	34 5	„ 1 41	0·3458	
III	Quetta	30 11 52	67 0 20	42 58	„ 2 57	0·3232	
IV	Bahâwalpur	29 23 27	71 40 37	41 59	„ 2 53	0·3319	
V	Râwalpindi	33 35 16	73 3 6	48 8	„ 3 46	0·3123	
VI	Bharatpur	27 13 31	77 29 28	38 43	„ 2 0	0·3460	
VII	Bangalore	12 59 35	77 35 58	9 45	W 0 35	0·3815	
VIII	Dhârwâr	15 27 26	74 59 35	15 17	„ 0 10	0·3763	
IX	Porbandar	21 38 20	69 37 6	28 39	E 1 16	0·3601	
X	Fyzabad	26 47 27	82 7 40	37 49	„ 1 50	0·3534	
XI	Sambalpur	21 28 3	83 58 26	27 48	„ 0 53	0·3731	
XII	Waltair	17 42 54	83 19 1	21 8	„ 0 21	0·3786	
XIII	Darjeeling	26 59 49	88 16 39	38 19	„ 1 40	0·3566	
XIV	Gaya	24 46 30	84 58 54	34 12	„ 1 13	0·3663	
XV	Secunderabad	17 27 11	78 29 16	20 8	„ 0 22	0·3791	
XVI	Bhusâval	21 2 46	75 47 18	26 53	„ 0 52	0·3681	
XVII	Jubbulpore	23 8 57	79 56 44	30 55	„ 1 6	0·3648	
XVIII	Tavoy	14 4 50	98 12 30	12 12	„ 0 38	0·3954	
XIX	Lashio	22 56 47	97 44 40	31 19	„ 0 51	0·3762	
XX	Akyab	20 7 53	92 53 18	25 28	„ 0 52	0·3828	
XXI	Silchar or Cachár	24 49 43	92 47 21	34 40	„ 1 16	0·3692	
XXII	Dibrugarh	27 29 24	94 55 40	39 28	„ 1 23	0·3585	

NOTE.—The above values of Dip, Declination and Horizontal Force are uncorrected for secular change, diurnal variation, instrumental differences, etc., and are to be considered as preliminary values only.
Where blanks occur, values have been already found during previous field seasons, or the observations have not been completed.
The Survey numbers refer to the published chart: thus No. $\frac{26}{3}$ 3 denotes No. 3 station in the dotted square the spherical co-ordinates of whose centre are 26° North Latitude, and 76° East Longitude.
All Longitudes are referable to that of Madras observatory taken at the value 80° 14′ 47″ East from Greenwich.

TOPOGRAPHICAL SURVEYS.

CENTRAL AND UNITED PROVINCES AND CENTRAL INDIA STATES.

NO. 1 PARTY (*VIDE* INDEX MAP NO. 1).

157. The party was again employed in completing standard sheets of which the Central Provinces portions had been surveyed. Field work commenced towards the end of October and continued till the end of May, when notwithstanding the long field season, the programme still remained unaccomplished. There has been some improvement among the many inferior surveyors in this party and they will be given another chance, but those who still remain inefficient at the end of the next field season will be discharged. Five soldier-surveyors were attached to the party for training, all of whom completed their second season's extra training, but none of them were recommended for retention in the Survey of India and were all sent back to their regiments.

Personnel.

Imperial Officers:

Major A. H. B. Hume, R.E., in charge up to end of February when he reverted to Home service.

Lieutenant K. W. Pye, R.E., joined the party on 7th October 1906 and in charge from 1st March to 17th June 1907.

Lieutenant M. N. MacLeod, R.E., in charge from 18th June 1907.

Provincial Officers:

Messrs. F. S. Bell, F. P. Walsh, W. Skilling, C. Litchfield, B. M. Berrill, and R. E. Saubolle.

Subordinate Establishment:

55 Surveyors, etc.

158. The greater part of the area surveyed lay in the United Provinces and Central India States adjoining the northern border of the Central Provinces, where the country is hilly and mostly covered with jungle, the hills having long gentle slopes on one side which were very difficult to survey. The outturn for the season and cost-rates are as follows :—

	Square miles.	R
Re-survey on the 2-inch scale of Central India States previously surveyed on the 1-inch scale.	664	38·2
Supplementary survey on the 2-inch scale of maps compiled from cadastral surveys in the United and Central Provinces.	838	25·7
Revision survey	432	21·8
Fair mapping	1906	6·7

The boundaries of 63 villages with a total length of 290 miles were traversed for the local government at a cost of R9,209. No triangulation was done. The work was based on the triangulation and traversing of the previous surveys, the altitudes of which, as mentioned in last year's report, are inaccurate. To rectify these, 816 linear miles of traversing was done, connecting the old work with a line of levelling of the G. T. survey, and the results were very satisfactory. The maps of all forests met with, which had been previously surveyed, were revised and also some of the contouring of former seasons, which was necessitated by the corrections that have now been applied to the heights.

159. The total area surveyed was 1,934 square miles, of which the survey of 200 square miles was done by men under training, and excluding them, the average outturn for the season per surveyor was 62 square miles. That of the men under training was 50 square miles. Taking each class of work separately, the average monthly outturn per surveyor of supplementary survey was 6·6 square miles and of re-survey 7·7 and the average number of plane-table fixings per square mile 24 for the former and 21 for the latter. The corresponding figures for revision survey were 11·2 square miles, 10 fixings and 7 heights. These latter figures, however, are misleading as the contouring having been based on inaccurate data, had to be completely re-done. This also affects the cost-rates.

160. The mapping was not quite completed during the recess, but the maps will be submitted for publication during the field season. No triangulation charts have been completed yet, but are in hand. The party was inspected by the Surveyor General during the recess and by the Deputy Surveyor General during both field and recess seasons.

161. Next season supplementary triangulation and traversing will be done in sheet 55M., although the whole sheet has hitherto been shown as surveyed during the present operations. There are, however, large forests in it which were surveyed several years ago, the maps of which were not revised. Also the contouring requires revision all through for the reasons given in para. 157. The following sheets comprising an area of about 3,250 square miles will be re-surveyed or revised :—Nos. $54\ \frac{L}{7,8,12,16}$; $54\ \frac{P}{4,7,8,12,16}$; $55\ \frac{M}{9\&13}$ and $55\ \frac{I}{5}$ As better arrangements have been made this season for preparing the ground in advance of the detail survey, it is confidently anticipated that this programme will be complete.

BERAR.

No. 2 Party (*vide* Index Map No. 1).

162. The instruction of newly joined Provincial officers and soldier-surveyors, together with a survey on the 2-inch scale of Berar in sheet 55, was continued. One Provincial officer was discharged at the close of the field season as unlikely to become an efficient surveyor.

Personnel.

Imperial Officer:

Captain H. Wood, R.E., in charge. On leave from 29th July to 8th September.

Provincial Officers:

Mr. C. J. Veale, in charge from 29th July to 8th September, and 15 Probationers.

Subordinate Establishment:

6 Soldier-Surveyors, 1 Surveyor, and 1 Computer.

Three of the soldier-surveyors completed their second season's training and have been recommended for retention in the department and transferred to the North-West Frontier. Field work commenced on the 16th October 1906 and closed on the 27th April 1907. The triangulation was extended over an area of 1,680 square miles of hilly and heavily wooded country. The average number of square miles to each point trigonometrically fixed and to each height was 2·5. The cost-rate of the triangulation is slightly higher than that of the preceding season, as the work of one officer had to be entirely rejected.

163. The area surveyed in detail was 1,296 square miles and consisted generally of flat cultivated land interspersed with low bare hills, excepting in a small area where the hills were jungle-clad. The average monthly outturn of detail survey of the Provincial officers was 11·8 square miles. That of the soldier-surveyors who were undergoing their second year's training 13·7 square miles, and of those in their first year 9·7 square miles. The average outturn per working day of both Provincial officers and soldier-surveyors was 0·5 square miles. All these figures include a 4-inch survey for the Forest Department of the boundaries of all A and B class reserved forests which fell in the area under detail survey. The total length of boundaries thus surveyed was 142 miles. The cost-rate of the detail survey has fallen considerably this year owing partly to the fact that there was only one Assistant Instructor. A second officer was not available, but has now been appointed.

164. The party was inspected during the recess by the Deputy Surveyor General. The computations were all completed as also the mapping, including the sheet left unfinished last year, and all the maps were forwarded to headquarters for publication. Next season sheets $55\ \frac{H}{1,2,5,6}$ and $55\ \frac{L}{3,4}$ will be triangulated, and sheets $55\ \frac{H}{4,7,8,12,16}$ will be surveyed on the 2-inch scale.

BOMBAY PRESIDENCY.

No. 17 Party (*vide* Index Map No. 1).

165. This party which has for many years been employed exclusively on forest surveys became available this season for regular topographical survey and has commenced work in sheet 46 under the administrative control of the Deputy Surveyor General. Mr. Gilbert-Cooper proceeded on long leave on the 4th April 1907. The party left Poona for the field about the 10th November 1906, and returned to recess quarters about the same date in May 1907. There was a certain amount of sickness during the cold months, especially north of the Tapti river, and one or two serious cases occurred, including Mr. Gilbert-Cooper, whose condition gave

Personnel.

Imperial Officer:

Mr. B. G. Gilbert-Cooper, in charge up to 4th April 1907.

Provincial Officers:

Mr. S. F. Norman, in charge from 5th April 1907.

Babu Amar Singh, Mr. J. H. S. Wilson, from 16th October 1906, Mr. P. R. Anderson, Babu A. K. Mitra, from 16th June 1907 and Mr. F. B. Kitchen.

Subordinate Establishment:

36 Surveyors, etc.

rise to some anxiety at one time. One surveyor developed a mild form of plague shortly after taking the field, and was on the sick list about a month. Dispensaries were, however, conveniently situated throughout the area under survey and medical assistance was readily obtainable, but the outturn was considerably affected, nevertheless.

166. The following table shows in detail the outturn, with cost-rates including mapping, for the year under report:—

	Square miles.	R
Triangulation . . .	2,155	5·5 per square mile.
Revision survey on the 2-inch scale	2,292	15·6 „ „
Re-survey „ „ „	348	31·6 „ „
Forest survey „ 4-inch „	62	65·8 „ „
	Linear miles.	
Survey of forest boundaries on the 4-inch scale.	140	4·7 per linear mile.

As this is the party's first season of work on the 2-inch scale, no comparisons can be made with the work of former seasons. The re-survey cost twice as much as the revision survey, but the latter includes 364 square miles of forests that had been surveyed comparatively recently and required very little revision and the area re-surveyed consisted chiefly of difficult country at the foot of the Satpura hills. The cost-rate of the forest survey does not include mapping. It was done for the Forest Department and consisted of 54 square miles of forest in the Nandurbar *taluka*, West Khandesh district, and 8 square miles of two organised forest blocks in the Sinnar *taluka* of the Nasik district. The boundaries of all forests that fell into the area under survey and had not been previously mapped were surveyed on the 4-inch scale.

167. The average monthly outturn per man for the various classes of survey and the outturn per working day are as follows:—

		Sq. miles daily.	Sq. miles monthly.	No. of plane-table fixings per sq. mile.
2-inch	Revision survey . .	0·70	16·4	16
	Re-survey . . .	0·34	8·0	39
4-inch	Forest survey . . .	0·12	3·3	113

The area surveyed in detail included a portion of the valley of the Tapti river which runs between high bare banks and was found to be identical with the old survey; even the water channel of the dry season having undergone no change whatever.

168. The Deputy Surveyor General inspected the party during the recess. The mapping has made good progress, and every effort has been made to reduce the large amount of arrears pertaining to last season. It is hoped that before the close of the recess, 22 maps on the 4-inch scale and 51 on the 8-inch scale will be submitted for publication in addition to the 8 standard sheets of this season's topography, for which Mr. Norman deserves much credit. The computations are somewhat backward, but it is expected that all will be completed before the party takes the field again in November.

169. During the coming season the existing triangulation in the area previously surveyed on the 1-inch scale in sheets 46 $\frac{O}{9, 10, 13, 14}$ and parts of 46 $\frac{O}{11 \& 15}$ will be supplemented and the survey of the following sheets will be revised on the 2-inch scale:—Nos. 46 $\frac{O}{4, 8, 12, 16}$ and 46 $\frac{K}{1, 5, 9, 10, 13, 14}$. Sheets 46 $\frac{K}{2 \& 6}$ which were partly surveyed during the current season will be completed, and the entire degree sheet will then have been surveyed. The survey of about 500 linear miles of the boundaries of forest reserves which fall into the area under survey will be done on the 4-inch scale.

BURMA.

No. 3 Party (*vide* Index Map No. 2).

170. The party was transferred from the administrative control of the Deputy Surveyor General to that of the Superintendent in charge of Burma Surveys on the 16th October 1906.

Personnel.

Imperial Officers:

Captain C. P. Gunter, R.E., in charge.
Lieutenant L. G. Crosthwait, I. A.

Provincial Officers:

Messrs. W. M. Gorman, J. Donaghey, E. Claudius, Munshi Asmatullah Khan, and Mr. H. D. W. Stotesbury.

Subordinate Establishment:

18 Surveyors, 4 Draftsmen, 1 Typer, 3 Writers and 1 Hospital Assistant.

171. The programme consisted of a topographical survey on the 1-inch scale of Degree sheet 94 F comprising parts of the Southern Shan States, Karenni, and of the Salween district situated immediately to the west of the Burma-Siam boundary, and the triangulation of Degree sheet 94 G.

172. The area under survey consisted almost entirely of a mass of very steep and rugged mountains rising to over 8,000 feet in the north-west and to 5,000 feet in the south-west, gradually falling to the Salween which is here about 350 feet above sea level. In Karenni the hills are bare and rocky but further south they become gradually covered with jungle growth, and at Papun the forest is of a tropical character and nearly impenetrable.

173. The party left its recess quarters at Bangalore on the 12th of November 1906 and the bulk of the party returned there on the 26th of June 1907. As the programme for 1907-08 lies in Upper Burma it was necessary to make every endeavour to complete sheet 94 F, and this was successfully accomplished though not without difficulty, one small detachment of the party having remained in the field until the 9th of July.

174. The health of the party in Karenni was good, but further south malarial fever was prevalent and near Papun it was so bad that no member of the party working there escaped from it. The rains broke near Papun in the beginning of May after which work was carried out under circumstances of unusual discomfort.

175. Great difficulties were met with in obtaining food supplies and local labour; means of communication were very difficult and the necessity for heavy jungle clearing further retarded the work. Chinese mules and ponies were hired to enable the officers to move freely about among their men and for the transportation of rations.

176. As it was decided in the middle of the field season that the party should be transferred to Upper Burma in the following (survey) year, triangulation was stopped and the assistants employed on it were transferred to the topographical camps to ensure the detail programme being completed. 1,399 square miles were triangulated and 1,266 square miles reconnoitred in sheet 94 G.

177. 2,859 square miles were topographically surveyed on the 1-inch scale in sheet 94 F, and 66 square miles of forest which had been previously surveyed on the 4-inch were revised on the 1-inch scale. 54 square miles were also re-surveyed in sheet 94 B. There was a small area of reserved forest which it was proposed to survey on the 2-inch scale, but it was found impossible to carry this out without risking the non-completion of the degree sheet, so it was abandoned and will be taken up later in conjunction with the survey of the next sheet. Owing to the steepness of the ground, contours were drawn at intervals of 100 instead of the customary 50 feet, but the intermediate contours will be inserted in the fair maps.

178. The average daily outturn of a surveyor was 1·29 square miles, the average number of plane-table fixings being 6·4 per square mile.

179. The cost-rate of triangulation R6-0-11 per square mile is moderate and that of detail survey R34-15-0 per square mile, although apparently high for 1-inch survey, may be considered satisfactory when the difficult nature of

the country is taken into consideration, and it compares favourably with that of former surveys in similar country.

180. On the return journey from Papun one of the boats capsized in the Yônzalin river and its contents, including some original field sections, sank and two assistants spent an unpleasant three days on a sand bank trying to recover the lost property: most of it was eventually recovered by *Karen* divers, including the field sections which, having been carefully packed in tin cases, were fortunately found to be undamaged.

181. Owing to the late return of the party from the field and to the delays consequent on the introduction of the new system of mapping it will be impossible to complete all the fair mapping of the area surveyed during recess. But this will, however, be done during the field season by draftsmen of the party who will be attached to the Burma Drawing Office for the purpose.

182. As the triangulation was incomplete, the computations have not been taken up.

183. The programme for 1907-08 consists of the completion of the detail survey of sheet 84 K on the 1-inch scale, forest reserves being surveyed on the 2-inch scale and of triangulation in sheet 84 J.

184. The party was frequently visited and inspected during the recess by the Superintendent in charge Burma Surveys.

UPPER BURMA.

No. 10 PARTY (*VIDE* INDEX MAP NO. 2).

185. The party was transferred from the administrative charge of the Deputy Surveyor General to that of the Superintendent in charge Burma Surveys on the 16th October 1906.

Personnel.

Imperial Officer:

Captain A. A. McHarg, R.E., in charge.

Provincial Officers:

Messrs. P. J. Barrington, M. J. Sheehan, W. G. Jarbo, E. M. Kenny and Munshi Abdul Rahim, K.S.

Subordinate Establishment:

21 Surveyors, 2 Writers, 1 Typer and 1 Hospital Assistant.

186. The programme consisted of the topographical survey on the 1-inch scale of ten standard sheets falling in Degree sheets 84 M and 84 N, comprising parts of the Shwebo, Katha, and Ruby Mines districts of Upper Burma, and of the triangulation of parts of Degree sheets 84 M and 83 P.

187. About half the area consisted of wooded hills of no great height but requiring a considerable amount of clearing, and the remainder, in the valley of the Mu and along the railway line, was either flat or slightly undulating.

188. The party left its recess quarters at Bangalore on the 7th of November 1905 and returned on the 12th of June 1906.

The health of the party was fair, although cases of fever were frequent. Two *khalasis* died during the field season and four others died of cholera contracted on the journey from Calcutta to Rangoon.

189. An area of 706 square miles was triangulated in advance. The work was of a patchy nature and was supplementary to triangulation which had been done previously, a good deal of clearing had to be done. The work occupied one Provincial Officer and one surveyor for about five months. Fifty-nine linear miles were traversed with a theodolite, chiefly along forest boundaries, to supplement the triangulation.

190. The detail survey consisted of original and supplementary surveys on the 1-inch scale, of 2-inch surveys of forests not previously surveyed and 1-inch revision surveys.

The outturn of each of the above classes was as follows:—

	Sq. miles.
Original survey, 1-inch	1,054
„ „ 2-inch	148
Supplementary survey, 1-inch	1,179
Revision survey, 1-inch	127
TOTAL	2,508

The country being for the most part undulating and thickly wooded, was not favourable for plane-tabling by interpolation and almost the whole area had to be surveyed by means of plane-table traverses, a slow and laborious process. The supplementary survey was carried out by examining and adding new detail to 1-inch reductions of the cadastral surveys; as the whole of the area thus surveyed had to be rigorously traversed, the rate of progress was not much faster than for original survey. In the revision survey special attention was paid to supplementary heights and to the classification of roads.

191. The average daily outturn of a surveyor was 0·95 square miles for 1-inch survey, 1·07 for 1-inch supplementary survey, and 0·40 for 2-inch surveys, the average number of plane-table fixings per square mile being 21 for 1-inch and 74 for 2-inch survey.

192. The cost-rates for the different classes of work are as follows:—

Nature of survey.	Cost per square mile.	REMARKS.
Triangulation	19·50	
Traversing	13·61	R23·07 per linear mile.
Detail survey, 2″=1 mile	54·06	
„ „ 1″=1 mile	39·84	
„ „ supplementary	30·25	
„ „ revision	12·19	

The rates are necessarily high owing to the nature of the country in which the party was working and the slow and laborious method of plane-table traversing by which the work had to be carried out. The high cost of traversing is due to the patchy nature of the work. The cost-rate of 2-inch survey and of 1-inch revision is moderate.

193. In addition to the regular work of the party Surveyor Lachman Jadu, R.S., was attached to a party which was employed on building boundary pillars on the Burma-China boundary between Panghsang Nalawt and the Mè-hkong river. He had not many opportunities for adding to the original survey of that part of the country which, however, will be surveyed by No. 11 Party in 1908-09 in ordinary course.

194. There was some delay in the fair mapping in consequence of a new system having been introduced, but it is expected that most of the maps will be drawn and sent to press before the party leaves recess quarters: any sheets which may be incomplete will be completed in the Burma drawing office.

195. The computations of the party have all been completed, and three triangulation charts will be sent to press before the end of the recess.

196. The programme for 1907-08 consists of the completion of the standard sheets on the 1-inch scale comprised in Degree sheet 84 M, also parts of Degree sheets 93 A and 93 E: the area to be surveyed in the latter is somewhat in advance of the general programme of the party, but is undertaken at the request of the Geological Survey Department which requires maps of this area on account of the development of the mines occurring in it.

197. The party was inspected in the field by the Surveyor General and the Superintendent in charge Burma Surveys, and also in recess by the latter officer.

SHAN STATES, BURMA.

No. 11 Party (*vide* Index Map No. 2).

198. The party was transferred from the administrative control of the Deputy Surveyor General to that of the Superintendent in charge Burma Surveys on the 16th October 1906.

Personnel.

Imperial Officers:

Captain R. H. Phillimore, R.E., in charge up to June 6th and again from September 8th to the close of the year.

Lieutenant L. G. Crosthwait, I.A., attached and officiating in charge from 7th June to 7th September.

Provincial Officers:

Messrs. S. S. M. Fielding and V. W. Morton.

Subordinate Establishment:

14 Surveyors, 2 Soldier-Surveyors, 1 Computer, 1 Writer, and 1 Hospital Assistant.

199. The party continued the detail survey of the Southern Shan States to the east of Longitude 99°30′ in the Kēngtūng State in sheets 93O and 93P and triangulation in the same State east of Longitude 100° in sheets 102 C and 102 D up to the Mè-hkong river which here forms the boundary between the Shan States and French Indo-China.

200. Application had been made by the political authorities for permission for the triangulators to cross the Mè-hkong into French territory, and His Excellency the Governor General of Indo-China readily assented to the proposal and most courtequsly sent an officer, Monsieur Salé, from Bān Houei Sai to meet our triangulators; they met at Kēnglap, but no stations were observed from in French territory although several points were fixed by intersection. A similar permission was obtained to enter Siamese territory in the south and two stations were observed from, which proved most useful in fixing points in the low-lying ground where the Siamese frontier meets the Mè-hkong.

201. The country surveyed consists of an intricate mass of jungle-clad hills and includes part of the high range which forms the watershed between the Salween and the Mè-hkong rivers. Villages were not so frequent and there were fewer paths than in the western portion of the Kēngtūng State; the forest growth was also more dense.

202. The party left its recess quarters at Tounggyi on the 4th of November 1906 and did not reach its ground until the beginning of December; field work was closed early in April and the party was ordered to Bangalore for recess in order that it might be reconstructed under the immediate superintendence of Lieutenant-Colonel Gordon, in charge Burma Surveys. A part of it returned to Burma *viâ* Hsipaw and part *viâ* Taunggyi. The distance from Kēngtūng to Hsipaw (which is only a few hours from Maymyo by rail) is 22 marches by a good fair weather mule road, while from Kēngtūng to Taunggyi it is 23 marches, but the former route has its advantages as the latter, when Taunggyi is reached, is still ten marches from the nearest railway station. For many reasons Taunggyi proved unsuitable for recess quarters and it has been decided to transfer them to Maymyo which will probably be one of the head-quarters of the Burma circle when it is formed, but pending final arrangements the party was, as a temporary measure, transferred for the recess of 1907, to Bangalore.

203. The health of the party in the field was not particularly good and nearly all the members suffered from fever during the earlier part of the season. Instead of importing all the *khalasis*, as in former years, an experiment was made in employing local labour and each surveyor had two Shans in his squad; little difficulty was experienced in obtaining these men who were frequently changed and worked cheerfully and well. The officer in charge, who has recently passed in the Shan language, made a point of getting to know the head men personally and, in consequence of this, supplies and labour were willingly provided. The *Sawbwa* of Kēngtūng detailed court officials to accompany the officer in charge and the triangulators, and these being men of influence were of great assistance in getting roads cleared and bridges erected.

204. 1,781 square miles were triangulated in advance, which, with the area previously triangulated, will provide sufficient points for the detail programme which it is hoped to carry out in 1907-08. The smoke haze which generally envelopes the country from February onwards was not nearly so troublesome as usual owing to frequent thunderstorms.

205. 1,612 square miles were topographically surveyed on the 1½-inch scale in Degree sheets 93 O and 93 P. This scale was adopted experimentally as the steepness of the ground prevented contours being drawn at the usual vertical intervals of 50 feet on the 1-inch scale.

206. The average outturn of the 1½-inch scale for a working season of four and-a-half months was 126 square miles per surveyor, as compared with 161 square miles on the 1-inch scale in the previous season, the average number of plane-table fixings being 8·2 per square mile as compared with 6·5 on the 1-inch scale in the previous season.

207. The cost-rate per square mile of the detail survey was R42·4. The cost-rate of triangulation was R8·7 per square mile as compared with R15·5 in 1905-06.

208. Special care was taken over the collection and transliteration of place names. Vernacular revenue registers were obtained from the *Sawbwa's* court at Kēngtūng which showed all villages arranged according to circles. These were transliterated by the officer in charge in consultation with the political authorities, and to each plane-tabler was then issued a correct list in English of all villages likely to fall in his work. Names of hills and streams were collected by the plane-tablers, and verified by the officer in charge or one of the assistants by enquiries in the immediate neighbourhood. In previous seasons too much reliance has been placed on names written in Burmese or Shan by illiterate *hpoon-gyis* and interpreters. Even had the names always been correctly recorded in Shan, accurate transliteration would not follow without local enquiry, for the Shan character has no signs to distinguish the closed series of vowels from the open series; and thus "*Lūng*" and "*Lōng*" would appear written alike, as also would "*Lēng*" and "*Ling*". The *Hkon* character which is used east of the Salween-Mè-hkong watershed, however, not only shows all these distinctions, but shows distinctions in the vowel tones; and the pronunciation of a word follows directly from its spelling. The village names as now recorded and printed on the maps give also the tribal name of the inhabitants. This change is regarded as of great value by the political authorities. Up to last season the tribal names were shown in brackets below the village name proper.

209. The five sheets fully surveyed were drawn during the recess and submitted for publication. The triangulation has been computed and the results are satisfactory.

210. The programme for 1907-08 is in continuation of that of the year under report, and it is hoped that the survey of the Southern Shan States south of the Wa country will be finally completed in 1908-09.

211. The party was frequently visited and inspected by the Superintendent in charge of Burma Surveys during recess.

MADRAS.

NO. 19 PARTY (*VIDE* INDEX MAP NOS. 2 AND 3).

212. The party was under the administrative control of Colonel Hodgson, I. A., Deputy Surveyor General, until the 14th July 1907 and thereafter of Lieutenant-Colonel Gordon, I. A., recently appointed Superintendent in charge of Burma Surveys, who resided at Bangalore, its recess quarters.

Personnel.

Imperial Officers:

Lieutenant-Colonel W. J. Bythell, R.E., in charge from 23rd November to 5th June 1907.

Captain F. F. Hunter, I.A., in charge from June 6th 1907.

Provincial Officers:

Messrs. G. T. Hall, in charge till 22nd November 1906, R. Waller-Senior, J. Smith, W. F. E. Adams, M. J. Sheehan, E. J. Biggie, B. C. Newland, Babus M. M. Mudaliar and Balaji Dhondiba.

Subordinate Establishment:

48 Surveyors, 1 Hospital Assistant, 2 Writers and 1 Record-keeper.

213. This party, which had been employed exclusively on forest surveys since 1886, commenced the 2-inch topographical survey of parts of the Malabar and Nilgiris districts and the revision on the 1-inch scale of part of the Mysore State.

The programme also included advance triangulation in the same districts, 4-inch forest surveys in the Ganjam and Coimbatore districts, and forest boundary traverses in Malabar and Trichinopoly.

214. The country under survey was of a varied description and included part of the Wynaad covered with dense jungle with numerous coffee plantations and many abandoned gold workings. Part of the coast tracts of Malabar was also surveyed, a long belt of land between the sea and the Ghâts most of it only a few feet above sea level with dwellings scattered over the entire area, each homestead consisting of a comfortable hut, standing in its own garden enclosure in which vegetables, as well as the pepper vine and betel and cocoanut palms, are cultivated.

In Ganjam the area surveyed consisted of wild rugged hills covered with jungle.

215. The party left Bangalore for the field during November 1906, and the last sections did not return until the end of June 1907.

216. The health of the party was not good, except in the coast tracts of Malabar. In Ganjam, Coimbatore and the Wynaad the party suffered severely from fever, and two deaths occurred among the *khalasis*. Almost daily rain occurred in Malabar from April onwards.

217. Supplies were generally plentiful, but except on the coast of Malabar, local labour was very scarce and of poor quality. In the Wynaad the work was seriously retarded by the difficulties experienced in procuring coolies; in Ganjam all labour was imported as the jungle tribes in that part not only refused to work, but actively interfered with the surveyors.

218. An area of 3,438 square miles was triangulated, chiefly in Degree sheets 49 M and 58 A. This is more than sufficient for the detail surveyors during the season 1907-08. It is based on the Great Arc meridional series, and the results are generally satisfactory. No use was made of the Madras Revenue survey triangulation as it was found impossible to reconcile it with the results of our triangulation.

219. 311 linear miles of forest boundaries were traversed by theodolite in Ganjam, Malabar and Trichinopoly.

220. The traversing of the Mysore-South Canara boundary commenced last year could not be finished as the demarcation was incomplete.

221. The area topographically surveyed on the 2-inch scale was 1,515 square miles, not including 116 square miles of overlap. 45 square miles of old 1-inch survey in the Mysore State were revised on that scale in order to complete standard sheets. The outturn of forest survey on the 4-inch scale was 374 square miles.

The outturn on the 2-inch scale was less than was expected, partly owing to the difficulties of country and climate, but principally to the surveyors being new to work on that scale. It is, however, satisfactory to note that as the men became accustomed to the scale of survey the rate of progress improved, and towards the end of the season was not under what was hoped for.

222. The average outturn per surveyor was 9·84 square miles per month on the 2-inch and 2·84 square miles per month on the 4-inch scale. The average number of plane-table fixings was 37·4 per square mile on the 2-inch and 98·6 on the 4-inch scale.

223. The outturn and cost-rates of the party for the year under report and the two previous years are as follows:—

Description of Survey.	Outturn.			Cost-rate per square mile.				
	1904-05.	1905-06.	1906-07.	1904-05.	1905-06.	1906-07.		
				₹	₹	₹	a.	p.
Triangulation 4″	1,012	70	2,555	14	33	5	4	11
„ 2″	...	2,150	3,412	...	6	5	11	3
Traversing 4″ to mile	29	174	311	31	28	13	12	6
Topography 4″	750	832	374	124	104	91	7	3
„ 2″ to 1 mile	...	...	1,515	...	...	45	1	8
„ Revision 1″ to 1 mile.	...	...	45	...	...	4	6	9
Overlap 2″ to 1 mile	...	...	116·5	...	...	.....		

The cost-rates compare favourably with those of former years. The decreases in the rates for triangulation and traversing are owing to the larger outturn. The decrease in 4-inch topography is principally due to the section employed on the work having been under the charge of a junior Provincial officer and also to the outturn having been large for one section. There is no exactly similar survey on the same scale to compare the rates of 2-inch surveys with, but, although high, they cannot be considered excessive after taking into consideration the difficulties of the country and the fact that none of the surveyors had any previous experience in 2-inch surveys.

224. The French settlement of Mahe was surveyed in the course of the work, through the kind permission of His Excellency the Governor of Pondicherry, and nothing could have exceeded the courtesy of the French officials who gave every facility for carrying out the work.

225. Five standard sheets have been mapped on the 2-inch scale and are ready for publication. Forty-four forest maps on the 4-inch scale were also completed and 35 remain in different stages. The forest boundaries shown on the maps have been verified by the local Forest officers.

Mapping.

226. All computations have been completed.

227. The programme for 1907-08 consists of the continuation of the topographical survey in Degree sheets 49 M and 58 B, with a revision of the area previously surveyed on the 1-inch and 4-inch scales, advance triangulation in Degree sheets 49 N and 58 B, and the completion of the 4-inch forest surveys in Ganjam.

The triangulation of Coorg will be also taken up in anticipation of the topographical survey of that province, which is considered urgent, and which will be commenced in 1908-09.

228. The party was frequently visited and inspected in recess by the Superintendent in charge Burma Surveys.

BURMA AND ASSAM.

NO. 20 PARTY (*VIDE* INDEX MAP NO. 2).

229. The party remained under the administrative control of Lieutenant-Colonel Gordon throughout the year, first as Superintendent, Forest Surveys, and then as Superintendent in charge Burma Surveys. Major Mears proceeded on combined leave to England on the 22nd October 1906 and was succeeded by Major Symonds who held charge of the party until the 18th June 1907, when he also went on combined leave, handing over charge to Mr. Prunty, Extra Deputy Superintendent, 2nd grade.

Personnel.

Imperial Officers :

Major A. Mears, I.A., in charge until the 14th October 1906.
Major C. W. H. Symonds, I.A., in charge from 15th October 1906 to 18th June 1907.
Lieutenant H. S. May, R.E., up to 14th April 1907.

Provincial Officers :

Messrs. P. F. Prunty, in charge from 19th June 1907 to the end of the year, C. C. Byrne, Babu Pramadaranjan Ray, Mr. J. H. Williams, Munshis Amjad Ali and Abdul Hai.

Subordinate Establishment :

43 Surveyors, 13 Traversers, 4 Draftsmen, 6 Computers, 2 Writers and 2 Hospital Assistants.

230. The programme of the party was a varied one. The 4-inch forest surveys on which the party had been employed in Burma since 1882 were nearly completed, and it had been decided that the party should next year be transferred to Assam for topographical surveys; for this reason a strong triangulation and traverse section was sent in advance to that province and employed in Degree sheet 78 P

which comprises parts of the Sylhet and Mymensingh districts and of Hill Tipperah State. A small section completed the 4-inch survey of the Mepalé forest reserves in Thaungyin; three surveyors carried out a forest boundary survey in Minbu, and the bulk of the party was employed on 2-inch topographical surveys in Degree sheets 84 J and 84 K, chiefly in the Pakôkku district. The 2-inch scale had been laid down as a large part of the area consisted of forest reserves for which 2-inch maps were essential.

231. The area under survey consisted of country of very varied nature. In Sylhet the ground was flat, being seldom over 50 feet above sea level and covered with swamps of large extent, and in the south and east by low hills with tea gardens. In Pakôkku district the area under survey consisted of wide valleys separated by ranges of wooded hills, and in Thaungyin steep rugged hills covered with dense evergreen forest were met with.

232. The party left its recess quarters at Dehra Dún on the 1st of November 1905, and after a field season of from six to six and-a-half months re-assembled at its new recess quarters at Bangalore early in June 1906. It is probable that on an early date the head-quarters of this party, which will probably be employed in Eastern Bengal and Assam for the next twenty years, will be transferred to Shillong.

233. The general health of the party in the field was good, but there was a serious outbreak of cholera on the journey to the field from which 19 *khalasis* died; 7 *khalasis* also died from fever in the field.

Lieutenant H. S. May, R.E., who was employed on triangulation in Hill Tipperah, suffered constantly from fever throughout the season, but continued his work in spite of having often to be carried to his stations. He eventually succumbed to an attack of black water fever while being taken into the nearest station.

234. Supplies were fairly plentiful in Burma, except in the extreme north of the Pakôkku district and in Thaungyin, where special arrangements had to be made. In Sylhet supplies were abundant and easily procured at the weekly markets.

Local labour was procurable in Burma, but in Sylhet the supply was scarce and unreliable.

235. *Assam.*—It was proposed to carry out a first class series of secondary triangulation in the south of Degree sheet 78 P, and the late Lieutenant May was entrusted with the work. Owing to the physical difficulties of the country this series was abandoned and a network was substituted, but little progress was made owing to Lieutenant May's sickness and death. Traversing was relied on for the provision of points for detail survey in 1907-08, in this sheet and 1,801 linear miles were observed with the theodolite with an average of four stations per mile. 856 permanent marks were embedded and all prominent objects near the traverse lines were fixed. The stations have been made over to the local authorities, and it is hoped that they will be useful for connecting the traverses of the local revenue surveys.

236. *Burma.*—An area of 1,563 square miles, of which 17 square miles were supplementary survey, was topographically surveyed in the Pakôkku district; over a fourth of the whole area, or 474 square miles, consisted of forest reserves. Owing to the nature of the country the work had to be carried out almost entirely by plane-table traversing and the surveyors were unaccustomed to the scale of survey. Progress was therefore slow.

Fifty-one square miles of forest reserves in Thaungyin were surveyed on the 4-inch scale: here, too, owing to the very difficult nature of the country, the progress was not so rapid as could have been wished.

Three surveyors also surveyed 500 linear miles of forest boundary on the 4-inch scale in Minbu.

237. The average monthly outturn of a surveyor was 8 square miles on the 2-inch and 2·56 on the 4-inch scale. The average number of plane-table fixings was 200 per square mile for 4-inch survey and 61 for 2-inch.

The outturn and cost-rates of the party for the year under report and the two previous years are given in the following table:—

Description of work.	Area surveyed.			Cost-rate in rupees per square mile.		
	1904-05.	1905-06.	1906-07.	1904-05.	1905-06.	1906-07.
Triangulation, square miles	800	1,622	...	7·8	9·1	...
1st class secondary (triangulation), square miles.	...	...	187	...	...	38·5
Traversing linear miles	976	881	1,801	44·5	42·6	20·5
Topography, 4-inch scale, square miles.	680	682	51	142·5	147·7	305·7
4-inch scale boundary survey, linear miles.	...	...	500	...	...	9·2 per L. M.
2-inch scale, square miles	...	...	1,546	...	...	65·5
Supplementary survey, square miles.	...	...	17	...	...	26·1

The cost-rate of triangulation cannot be compared with those of former years as the work was incomplete, having been abandoned at an early stage owing to the death of Lieutenant May. The cost of traversing is just half what it was during the two previous years; this was due to the country being flat and little clearing being required. The cost-rate of 4-inch surveys was abnormal, being twice as large as the average of the party for the last two years; all the conditions were adverse; the area was a small one and was situated in a remote part of the country where special rationing arrangements had to be made. The jungle was very dense and there was much sickness among the men.

It was anticipated that the work would be completed in two months, but in reality it occupied three. The cost-rates of small detached areas cannot be satisfactorily compared with those of large blocks.

The cost-rates of 2-inch detail survey were high; this was due to the country being intricate and difficult and to the work having been carried out by plane-table traverses, a slow and expensive process, instead of by interpolation which was impracticable. The rate though high does not compare unfavourably with the rates of former surveys on the same scale in Burma.

238. The relations with the inhabitants of Sylhet were somewhat strained at first and some of the traverse stations were destroyed, but later on, when the people understood the nature of the work, they became more friendly.

239. The mapping of the 4-inch surveys was undertaken by the Forest Survey Office at Dehra Dún and the maps of the Mepalé reserves have now all been published. The 2-inch mapping, consisting of six standard sheets, will be completed before the party takes the field. The maps were drawn on the 2-inch scale for reduction to the 1-inch standard sheets and special editions on the 2-inch scale of the forest portions will be published for the use of the Forest Department.

240. The computations have been completed and plot sheets prepared for next season's work.

241. The programme for 1907-08 consists of the topographical survey of Degree sheet 78 P and the triangulation and traversing of Degree sheet 83 D.

242. The party was inspected in the field in Burma and in Assam and during the recess at Bangalore by the Superintendent in charge Burma Surveys.

NORTHERN CIRCLE.

NO. 9 PARTY (*VIDE* INDEX MAP NO. 1).

243. This party which had previously been employed on forest surveys in the Madras presidency and in other parts of India was re-organised and transferred to the Punjab at the commencement of the field season.

Personnel.

Imperial Officers :

Major F. W. Pirrie, I.A., in charge up to 10th June 1907.
Lieutenant S. W. S. Hamilton, R.E., in charge from 11th June to 22nd July 1907.
Lieutenant E. C. Baker, R.E., in charge from 23rd July 1907.

Provincial Officers :

Messrs. J. A. Freeman and P. A. T. Kenny up to 15th May 1907.

Subordinate Establishment :

17 Surveyors, 4 Computers, 2 Clerks and 2 Soldier-Surveyors.

It was employed on topographical surveys on the scales of 4 inches and 2 inches to 1 mile in Dera Gházi Khan district of the Punjab.

The work was controlled where necessary by theodolite traverses and triangulation and a large area was triangulated in advance.

West of Dera Gházi Khan in the nearly flat ground the old revenue maps on the 4-inch scale of 1874-75 were used as a basis of the topographical surveys. It was found necessary to re-traverse part of the ground in order to further control the work, and near Choti-Bala and Sakhi-Sarwar in sheet 39 $\frac{K}{1}$ and elsewhere where the ground was undulating and hilly, it was found necessary to triangulate the whole ground and carry out an original survey on the 2-inch scale.

Both the 4-inch supplementary survey and the 2-inch original survey are being fair drawn on the 2-inch scale for publication on the 1-inch.

The triangulation of sheet 39 $\frac{K}{1}$ was carried out by Major F. W. Pirrie and computed in the field. The remaining triangulation was done by Lieutenant S. W. S. Hamilton, R.E., and Mr. P. A. T. Kenny.

The field office opened at Dera Gházi Khan on the 15th December 1906, and closed on 10th June 1907.

244. The outturn of the party for the season is as follows :—

Original 2-inch survey	258·36	square miles.
Revision 4-inch survey	257·72	„
TOTAL	516·08	„

The 2-inch work comprised the whole of standard sheet No. 39 $\frac{K}{1}$
„ 4-inch ditto ditto ditto „ 39 $\frac{J}{12}$

1,897 square miles of country were triangulated.

This area is in standard sheets 39 $\frac{J}{2, 3, 4, 5, 6, 7, 8}$ and portions of $\frac{J}{10, 11}$. In sheet 39 $\frac{J}{12}$ traversing was necessary. The origin of traverse was Gola G. T. station.

245. The cost-rates for survey are very high owing to so great a proportion of the members being new to this style of work and practically under instruction. They are—

	₹	a.	p.	
4-inch revision survey (including traversing)	73	11	9	per square mile.
2-inch original survey	40	2	11	ditto.
Triangulation	13	1	9	ditto.

The character of the country surveyed was very varied. The eastern portion of sheet 39 $\frac{J}{12}$ borders on the Indus river and is flat and artificially irrigated by wells and inundation canals. The western portion is flat, but not irrigated and has few wells; there is, however, a system of embankments built to catch the flood waters which are discharged from the hills in the rainy season.

The ground in sheet 39 $\frac{K}{1}$ is flat in the extreme south-east, but changes to low hills and then to a high, broken and precipitous range as you go westwards and to the north.

NORTHERN CIRCLE.

NO. 12 PARTY (*VIDE* INDEX MAP NO. 1).

Personnel.

Imperial Officers:

Captain E. T. Rich, R.E., in charge up to 12th September 1907.
Lieutenant M. N. MacLeod, R.E., up to 17th June 1907.
Lieutenant S. W. S. Hamilton, R.E., in charge from 13th September 1907.

Provincial Officers:

Munshi Rahmatullah, Mr. W. Newland from 22nd September 1906, Babu Dhani Ram, Messrs. H. C. W. Stotesbury and F. H. Grant from 9th June 1907.

Subordinate Establishment:

27 Surveyors, Computers, Writer, etc., and 3 Soldier-Surveyors.

246. Captain E. T. Rich, R.E., was in charge of the party until the 13th September 1907, when he proceeded on privilege leave, and Lieutenant S. W. S. Hamilton, R.E., took over charge.

247. The party worked in the Pesháwar district.

It completed—

(*a*) a network of triangulation over an area of about 4,730 square miles.

(*b*) detail survey on 2-inch scale of 1,230 square miles.

248. The detail survey work was carried out on 59 plane-tables and was tested by 1,309 *in situ* fixings.

249. The cost-rate of the detail survey and of the triangulation is as follows:—

	₹	a.	p.	
2-inch detail survey	53	10	4	per square mile.
Triangulation	8	13	11	ditto.
Fair mapping	15	0	9	ditto.

The cost-rates this year are less than half those of the last season, which is satisfactory.

250. The work in the field was closed on the 13th June 1907, when the party returned to Mussooree for recess.

The arrears of the last year's fair mapping and that of all the sheets surveyed during the current year are well in hand, and it is hoped that they will mostly be completed by the end of this recess.

251. During the ensuing field season the party will survey parts of the Pesháwar district.

252. The health of the party during the field season remained very satisfactory, but 2 *khalasis* were killed in a tribal skirmish and a surveyor and his squad were captured by tribesmen and held captive for four days.

253. The party was inspected twice during the field season by the Superintendent, Northern Circle, and during recess by the Surveyor General.

NORTHERN CIRCLE.

NO. 14 PARTY (*VIDE* INDEX MAP NO. 1).

254. As indicated in last year's report, this party worked in an easterly direction through Kohát district.

Personnel.

Imperial Officers:

Captain H. L. Crosthwait, R.E., in charge.
Lieutenant E. C. Baker, R.E., from 1st October 1906 to 22nd July 1907.

Provincial Officers:

Messrs. J. O. Greiff to 25th November 1906, H. H. B. Hanby, J. H. S. Wilson to 15th October 1906, E. J. Biggie, H. B. Simons, C. West, A. B. Hunter, B. C. Newland to 30th June 1907, A. G. Harrington to 3rd August 1907 and A. A. Graham from 10th July 1907.

Subordinate Establishment:

43 Surveyors, etc.

255. The total area topographically surveyed on a scale of 2 inches = 1 mile was 1,547 square miles. The cost-rate per square mile works out at ₹39·8.

256. The area triangulated was 4,495 square miles, of which 3,808 square miles is in advance of the detail survey and will be utilised during the coming season. The cost-rate is ₹7·2 per square mile, including computations and the preparation of charts.

257. The fair mapping of the following sheets was taken up and should be almost completed by the end of this recess; 38 $\frac{K}{15, 16}$, 38 $\frac{O}{2}$ (southern portion, north not yet completely surveyed): 38 $\frac{O}{3, 4, 7, 8}$ (northern portion). The cost-rate for mapping works out to approximately R10·8 per square mile.

258. Taking the total cost, including triangulation, topographical survey and mapping, the amount spent on a fair sheet drawn on a scale of 2 inches=1 mile for reduction to 1 inch=1 mile in standard form, having an area of about 250 square miles, works out approximately to R14,500.

259. The programme for the ensuing season is in continuation of last season's work in an easterly direction.

NORTHERN CIRCLE.

NO. 18 PARTY (*VIDE* INDEX MAP NO. 1).

260. The party was occupied during the year with the following duties:—

Personnel.

Imperial Officers:

Captain E. A. Tandy, R.E., in charge.
" M. O'C. Tandy, R.E., till 5th November 1906.
Lieutenant V. R. Cotter, I. A., from 6th October 1906.

Provincial Officers:

Messrs J. Marten till 16th April 1907, C. George from 16th October 1906 till 31st May 1907, C. J. S. Rae, C. E. C. French till 31st May 1907, J. R. Newland, Babu Maya Das Puri, Messrs. L. Williams from 8th February 1907 and F. C Pilcher from 10th July 1907, Mr. W. Robert, especially re-employed till 31st March 1907.

Subordinate Establishment:

34 Surveyors, 48 Draftsmen and Computers, 3 Writers and 1 Soldier-Surveyor.

(*a*) Triangulation in Bannu, Kohát, Dera Ismail Khan, and Miánwáli districts.

(*b*) Traverse and compilation in Bannu and Dera Ismail Khan districts.

(*c*) Plane-tabling and fair mapping of parts of Bannu and Dera Ismail Khan districts.

(*d*) Miscellaneous traverse work, including the completion of that in the Jhelum colony; a special traverse, including the laying down of base lines in a large part of the Bári Doáb desert; and the preparation of traverse data in a suitable form for laying out rectangles in the Rechna Doáb portions of the Lahore and Montgomery districts.

(*e*) Punjab riverain surveys, including the preparation of boundary maps on all the rivers of the Punjab, and some special supplementary traverse to assist demarcation on the Beas river.

(*f*) Arrears of mapping, including some Himalayán and Punjab sheets.

261. The change in the *locale*, coupled with the shifting of the office from Simla to Dehra Dún, caused a good deal of trouble at the commencement of the field season.

The area finally allotted for survey in the Bannu and Dera Ismail Khan districts was almost entirely without triangulation or heights; and the only fixed points available were the village trijunction pillars fixed by the old revenue survey of 30 years ago. These were, over a large part of the aera, so few and far between, that supplementary traverse work had to be carried out. At the same time triangulation had to be pushed rapidly along the Marwat and Bhittani ranges which separate the two districts.

The result was that work had to be commenced in very enclosed country where compilations of the old surveys would have been specially valuable as forming the basis of the new work; as soon as compilations had been made, the plane-tables first sent out were recalled and the compilations added to them; they were then sent out again for completion. The traversed heights could not be closed properly until the triangulated points on which they were based had been computed out, and as this was not done till late in the season, practically the whole of the plains portion of the work had to be gone over again to put in the contours. In the hilly ground the triangulation was not ready till so late that the surveyors had in the end to be crowded into the three sheets containing it, in order to get them finished, eight surveyors having in one case to work on one quarter sheet.

'All the arrangements arising from the moves at the end of recess had made it impossible to finish any of the 16 fair sheets that were in hand last year. They were therefore taken to the field head-quarters at Bannu and the last of them was sent to press late in March 1907.

A second triangulator had to be obtained from the Quetta party during the field season, and computers from other parties.

262. The country surveyed was entirely new to officers and men, and there were constant difficulties in providing water, escorts and transport; it was also a most unhealthy year and several deaths and a good deal of sickness occurred.

263. Owing to unavoidable delays the party office did not close at Simla till November 10th; it opened on 20th at Bannu, the field *khamal* having meanwhile been moved there from Multán; the Himalayan and Riverain sections with all old records, etc., moved from Simla to Dehra Dún about the same time.

Head-quarters were moved from Bannu to Dera Ismail Khan early in May and the field office was closed on the 23rd May and re-opened in Mussooree on the 1st June.

264. *Triangulation* was carried across all the hills in the north of Dera Ismail Khan district which separate it from Bannu; a further chain was carried along the Maidan range east of Bannu connecting with No. 14 Party's work in Kohát district.

Two triangulators were employed on the work and the area and cost-rate were 1,240 square miles and ₹11·2, respectively.

1,099 linear miles of supplementary traversing was done at a cost of ₹6·6 per linear mile.

Mr. Rae, in charge of all this, had to leave for Montgomery in the middle of January to take charge of the Bári Doáb work, after which it had to be carried on without an assistant.

265. *Plane-tabling and fair mapping.*—Six sheets, 38 $\frac{L}{9, 10, 11, 12, 13, 14}$ were completed to margin; two sheets, 38 $\frac{L}{8 \text{ and } 15}$ were commenced; and in 3 sheets, 38 $\frac{L}{1, 5, 6}$ as much work was done as political considerations would allow.

The total area surveyed was 1,881 square miles and the cost-rate ₹31·8.

In the northern parts of the Bannu Doáb the ground is very enclosed, being covered by high sugarcane cultivation, trees and villages, and it is intersected by innumerable water channels; in the centre of the district there are large areas of impassable clay ravines, running to depths of 60 or 70 feet. The rest of the plains are nearly waterless, and the ground is difficult to portray, one common feature being that river beds and deep nullahs gradually dwindle away to nothing as one follows their course downwards.

The intricacy and broken nature of the small ranges between Bannu and Dera Ismail Khan makes it impossible to show them satisfactorily even on the 2-inch scale, and the fair drawing is very difficult.

The fair mapping of all the work will be finished by the end of recess, except sheets 38 $\frac{L}{8 \text{ and } 15}$, the survey of which is incomplete.

266. *Miscellaneous Punjab traverse work.*—On the work in Jhelum colony nine traversers were employed, commencing work on the 20th November and being gradually transferred to the Bári Doáb in the months of January and February. Six hundred and twenty-six linear miles of supplementary traverse were done at a cost of ₹10·6 per mile.

Meanwhile arrangements had been concluded with the Punjab Government to traverse and lay down base lines over the whole of the desert areas of the Bári Doáb, in Montgomery and Multán districts, on their guaranteeing a grant of ₹10,000 to cover the cost of buying and embedding mark-stones.

The work consists of first traversing, and then laying out from the traverse lines, base lines about 2½ miles apart over the whole area, the object being to prevent men working on the square system from going far astray in laying out and apportioning land in the new colony, and to enable the Punjab Settlement staff to break up the whole area into one system of rectangles without an accumulative error.

Better and probably cheaper methods of attaining the desired results could be easily devised if the whole work were carried out professionally, but the procedure adopted appears that best calculated to assist the settlement survey staff, and the work should save an immense amount of delay and confusion in the

creation of the new colony, and should also afford settlement maps which will form a reliable basis for future topographical surveys.

195 bases, covering an area of 1,123 square miles, were laid down, and some work traversed ahead, at a cost of R20,811, during the past season; and it is hoped to get the remaining area, about 3,000 square miles, completed at a cheaper rate during the coming field season.

Captain M. O'C. Tandy's method of using existing traverse data to assist settlement surveyors in breaking up extensive areas into rectangles appears to have been a great success in Gujránwála district, as the results are reported to be two or three times as cheap and more accurate than if they had been carried out without this assistance; to this may be added the important advantage of having the whole country on one system of rectangles, which certainly could not otherwise have been effected with any approach to accuracy.

This procedure, again, is a compromise with the existing Settlement methods, and does not by any means secure the most advantageous use of the existing traverse data; but in existing circumstances it has certainly been a compromise worth making, and this year the party has supplied further data for the extension of the same system of rectangles into the Rechna Doáb portions of Lahore and Montgomery districts.

The area for which data were supplied last year was 1,530 square miles, and that now supplied is 920 square miles.

267. *Punjab riverain surveys.*—The fair mapping and compilation has suffered somewhat owing to the transfer of the party from the Punjab. It is hoped to remedy this difficulty by locating the office in Lahore during next field season.

The first practical test on a large scale of the advantages of the riverain maps was made last cold weather when, by the use of the survey maps and the deputation of a traverser to locate fresh marks on the ground, all discrepancies in the boundaries between Kapurthala State and Amritsar were brought forward and, for the most part, at once disposed of.

Babu Maya Das Puri has continued to carry on this most difficult work with discretion and energy.

268. *Arrears of mapping.*—The chief arrears of the party are those which the Himalayan section was specially organised to dispose of. This section was transferred from the party to the charge of the Superintendent, Frontier Surveys, from 1st April, by which time it had arrived within measurable distance of the end of its labours.

As already described, the Multán standard sheets were all disposed of during the field season, and the current mapping is now absolutely up to date.

The only work outstanding next year will be a certain number of triangulation and traverse charts, and large scale town maps of Amritsar, Baháwalpur and Dera Gházi Khan, which were brought up to date at the time of survey, and should be re-drawn as soon as time permits.

269. One soldier-surveyor fell ill very early in the season, and was brought into Bannu, where he died in hospital; one computer died on return to recess, after much hardship working with a triangulator in very waterless hills till the end of May. Six *khalasis* died during the season, and there was a great deal of fever and dysentery in all ranks.

NORTHERN CIRCLE.

TRAINING PARTY (*VIDE* INDEX MAP NO. 1).

270. The party was formed on 1st October 1906. Mr. Petters (and Mr. P. A. T. Kenny who was lent to this party) left Dehra Dún in the middle of October to take up the triangulation. Owing to a difficulty in obtaining labour, they were unable to commence work till nearly the end of October.

Personnel.

Provincial Officers:

Mr. G. P. Tate in charge, and Mr. M. C. Petters.

Subordinate Establishment:

4 Instructors, 18 Surveyors (under training), 2 Traversers, 3 Soldier-Surveyors, and 1 Writer.

On 5th December the detail surveyors assembled at Jhelum and the same difficulty was experienced in organizing the staff of *khalasis*. But the time was utilized to compute the triangulation and the plane-tables were plotted and men sent out to work by degrees, and by the end of December every camp was out of Jhelum.

Four camps were formed under four experienced surveyors as instructors. One of these, Surveyor Kader Sharif, had to leave the field owing to serious illness. Two of the instructors proved unable to stand hard work, and but for the zeal and energy of the fourth, Surveyor Ghulam Hyder Khan, the outturn and quality of the work would have suffered.

271. Training was carried on under service conditions. One man only was found to be not suitable and discharged from the field. The quality of the work was good. The men under instruction were anxious to learn. Owing, however, to want of practice in drawing, the delineation of the country is much weaker than the survey.

Work was rigorously tested. All work not up to 1st class standard was rejected, re-surveyed, or revised. The general character of the ground surveyed was difficult. Sheet No. 43 $\frac{H}{9}$ was completed and some work was also done in sheet No. 43 $\frac{G}{12}$.

An area of 322 square miles was surveyed on the 2-inch scale and 1,059 square miles triangulated. Cost-rates have been omitted as this is a training party.

272. Plague broke out with great virulence towards the close of the field season, but the party did not suffer from it.

273. The head-quarters of the party were removed from Jhelum to Rohtas in January, and in February to Dina, where the Superintendent, Frontier Surveys, inspected the party.

The party entrained at Dina railway station on the 13th and work was resumed at Dehra on 23rd May.

Systematic instruction has been going on during the recess and the men have shown a praiseworthy desire to improve.

CADASTRAL AND TRAVERSE SURVEYS.

BENGAL AND EASTERN BENGAL (*VIDE* INDEX MAP NO. 2).

274. The operations in Bengal and Eastern Bengal were under the supervision of Major R. T. Crichton, I.A., Superintendent of Provincial Surveys, until March 28th, 1907, since when, Major Crichton going home on well earned leave, Captain F. C. Hirst, I. A., has officiated. The work was carried out by 3 parties, one of which comprising one traverse and two cadastral sections was very large.

The outturn for the year is as follows:—

	Bengal.	Eastern Bengal.
Traversing	6,309	1,022
Cadastral survey	1,683	...
Record-writing	1,845	...
Topographical surveys on the 4-inch and smaller scales	1,591(*a*)	...

(*a*) Excluding 51 square miles in Monghyr.

NO. 4 PARTY (BENGAL).

Personnel.

Imperial Officer:

Captain F. C. Hirst, I.A., in charge till 28th March 1907.

Provincial Officers:

Messrs. N. Bedford in charge from 29th March 1907, T. W. Babonau, E. G. Hardinge, C. A. O'Donel, J. C. C. Lears, O. J. H. Hart, P. Kennegy, F. W. Marten, A. B. Smart, I. Newton, J. H. Johnson.

Subordinate Establishment:

3 Supervisors, 4 Hospital Assistants, 19 Writers and Accountants, 63 Computers, Draftsmen, etc., 49 Traversers, 8 Head Inspectors, 54 Inspectors, 933 Amins, 933 Moharrirs and 1,965 Menials.

275. This party consisting of one traverse and two cadastral camps was employed in the Bhágalpur, Monghyr and Patna districts, and also carried out a number of petty surveys.

276. The outturn of the season is as follows:—

District.	Nature of operation.	Area in square miles.	Cost-rate per square mile.
Monghyr	Traverse	1,190	35·9
	Cadastral	1,307	53·0
	Record-writing	1,307	52·0
	Triangulation for topography	275	...(*a*)
Patna	Traverse	852	34·2
Bhágalpur	Cadastral	375	61·1
	Record-writing	538	48·4
Various	Petty surveys, excluding linear relaying work.	29	...

(*a*) The cost is included under the heading "Traverse."

The cost-rates for traversing are fair when it is considered that a portion of the area dealt with was very rough in character and much jungle clearing was required. The rates for cadastral and record-writing are good.

277. The traversing has been suitably connected with the Great Trigonometrical stations and proves well. There were 31,714 theodolite stations which were marked by 4,364 stones at village trijunctions, 25,871 cylinders and 1,479 pegs. Demarcation was as a rule fair.

The detail survey was checked by 3·5 linear miles of test survey per square mile of detail work, and over 27% of the record entries have been checked by the survey staff. This party will in future do no cadastral work; such operations for the whole of Bengal being handed over to the Settlement Department from the first of October 1907.

An attempt to deal topographically with some 275 square miles of rough country in South Monghyr failed as an unexpected alteration in programme necessitated the employment of the staff retained for this, on other work.

The programme for next year consists of the completion of the traversing of the Patna district and the traversing of about 350 square miles of the Shahabad district. In addition several petty surveys and the topographical survey of the 275 square miles of Monghyr district referred to above will be carried out.

NO. 5 PARTY.

278. This party dealt with traverse work for cadastral survey in the districts of Midnapore, Ranchi, Singbhum and Sonthal Parganas. In addition one or two petty surveys were carried out.

Personnel.

Provincial Officers:

Messrs. C. S. Kraal in charge, C. H. G. Johnson and L. B. Fitz-Gibbon.

Subordinate Establishment:

2 Supervisors, 55 Traversers, 34 Computers, etc., and 693 Tindals and other Menials.

The total outturn was as follows :—

District.	Nature of operation.	Area in square miles.	Cost-rate per square mile.
Ranchi	Traversing for cadastral survey	1,128	37·3
Sonthal Parganas	Ditto ditto	807	26·6
Singbhum	Ditto ditto	601	30·4
Puri	Ditto ditto	97	49·1
Midnapore	Ditto ditto	15	24·8
	TOTAL	2,648	

279. The cost-rates for traversing are very fair considering the scattered nature of the programme.

280. The work has been connected with the Great Trigonometrical survey and proves well except in Singbhum; there somewhat high corrections had to be applied as the ground was very rough in places; the subtense bar was in frequent use both in Ranchi and Singbhum. In all 50,203 theodolite stations were used; of these the village trijunctions are marked by 4,789 stones or marks on existing stones and the remainder by 45,414 galvanized iron cylinders, stones, pegs or marks cut on rocks. The demarcation was on the whole very fair.

281. The programme for the next year is the completion of the traversing of the Ranchi district (1,172 square miles), the traversing of about 630 square miles of Manbhum and of 210 of Midnapore and of 15 of Singbhum district.

NO. 6 PARTY (EASTERN BENGAL).

Personnel.

Provincial Officers:

Messrs. A. W. Smart, late Extra Deputy Superintendent, in charge, O. E. C. Judd, P. F. Delaney, L. B. Fitz-Gibbon, T. F. Kitchen and B. F. Cooper.

Subordinate Establishment:

1 Supervisor, 43 Traversers, 21 Surveyors, 35 Clerks, Computers and Draftsmen, 900 Guards, Tindals and Khalasis and 4 Hospital Assistants.

282. This party comprised one traverse and one combined traverse and topographical section.

The areas accomplished are as follows :—

District.	Nature of operation.	Area in square miles.	Cost-rate per square mile.
Jalpaiguri	Traverse for cadastral	1,018*	72·2
24-Parganas	Traverse and topography, 4-inch	638	76·0
Khulna	Traverse and topography, 2-inch	953	92·9

* In addition 4 square miles were traversed for petty survey work.

The rates are good considering the nature of the country.

283. In Jalpaiguri there were 19,604 theodolite stations, which were marked as follows:—5,527 stones, 867 galvanized iron cylinders, 486 pucca pillars, 78 iron posts, 42 wooden posts, and 12,604 pegs. In the Sunderbans area the 6,592 new stations have been marked by 1,331 trunks of trees cut down to the required height, 5,046 pegs and 215 galvanized iron cylinders; the marking of stations was done on the same principles as reported last year. Zigzag traversing with the subtense bar was again adopted, the area dealt with being very thickly wooded and consisting of a very complicated network of streams and creeks; the results of this traversing proved well.

284. The difficulties hitherto experienced in the Sunderbans survey repeated themselves; in order to convey fresh water and stores to suitable centres, a fleet of 2 steam launches, 3 flats and 85 boats was maintained.

285. The survey of the 24-Parganas Sunderbans is now completed and that of the Khulna Sunderbans will be finished next year; in addition to this programme, the survey of about 900 square miles of Jalpaiguri and 1,200 of Mymensingh and Faridpur will be taken up next year.

MISCELLANEOUS SURVEYS.

286. The miscellaneous surveys dealt with were as follows:—

(*a*) *Calcutta Municipality.*—The mapping for the re-survey of the Calcutta suburban areas and the Dihi Panchannogram is still in hand; progress in the latter is delayed owing to work in many cases having to be held up pending the attestation of that already done; out of 397 maps of the suburban area for the Calcutta Corporation only 37 remain to be drawn; these sheets lie along the junction of the city and suburban areas, and steps are being taken to revise the city sheets affected, so that they may fit on to the new suburban sheets accurately. Of 469 sheets of the Panchannogram Estate, 256 have so far been drawn. The revision of the city survey itself is also probably about to be undertaken.

For the Port Commissioners an area of 1,498 acres was traversed and 600 surveyed in detail; this area covers a portion of the lands to be acquired for dock extension by the Port of Calcutta.

(*b*) The Colgong Municipality of district Bhágalpur was traversed and cadastrally surveyed, a record-of-rights being also written.

(*c*) A cadastral survey was made of village Mawalikabad in district Bhágalpur.

(*d*) 15 villages of Purnea and Bhágalpur lying in the Kosi *diara* were traversed and cadastrally surveyed.

(*e*) The work along the Mechi river (Nepal-Darjeeling boundary) was finally completed, an assistant being sent to point out the positions of the points selected last year for the boundary pillars; some of these had been lost, because the local authorities had been unable to put down permanent marks at the time of the original demarcation.

(*f*) The boundary between Nepal, Bhágalpur and Purnea around the point of entry of the Kosi river into British territory was examined with a view to deciding how far permanent marks could be erected in the old beds of that river with safety; this question will be finally settled next year.

(*g*) A 2-inch map of the Jamálpur Municipality (district Monghyr) was made in order to complete the preliminary standard sheets of that district, the Municipality having been omitted intentionally from cadastral operations.

(*h*) The last survey of the Binda *diara* (district Monghyr) was examined, certain boundaries having been lost; these were rectified.

(*i*) The record of occupancy of the Bhágalpur Municipality, compiled two years ago, was examined as it was found to be faulty in places; every plot was checked and all mistakes were corrected.

(*j*) Some work on the boundary between Udaipur State and Bilaspur district of the Central Provinces was carried out to assist the Commissioner appointed to decide that boundary dispute.

(*k*) A map was made showing the position of certain lands in Ghorapakhia (district Malda) with reference to previous surveys, so that the Collector of Malda might be able to decide a long standing dispute in the bed of the Ganges river.

(*l*) The Revenue survey boundary of Maldanga in district Malda was relaid at the request of the Collector of that district.

(*m*) Some petty arrears work in district Dacca were carried out but an inundation prevented the completion of this work which will now be held over until the survey of the district is resumed; this will probably be in survey year 1910-11.

BENGAL DRAWING OFFICE.

287. As reported last year, the work of this office falls under seven main sections:—

(*a*) *Standard mapping.*—North Bihár falls in 77 standard sheets, some of these being the old size, and some of the new size; up to the end of last year 38 of old size sheets altogether had been sent for publication; during this year 5 of old size and one of new size, covering portions of the districts of Darbhangha, Bhágalpur and Purnea, have been sent for publication; six others are nearing completion.

In Eastern Bengal and Assam, 6 sheets of old size and 3 of new size of Tippera and Backergunge were in hand during the year, 1 was sent for publication and the others are in various states, 6 being practically ready for publication.

(*b*) *District maps.*—The district maps of Darbhangha and Chittagong have been sent for publication, and those of Monghyr and Bhágalpur will be commenced shortly.

(*c*) *Traverse Charts.*—In Orissa, out of 49 charts forming the Orissa division, 13 have been sent for publication, and 15 others are practically completed; 10 remain to be examined, and the remainder are well in hand. The charts of North Bihár will be commenced as soon as Orissa has been dealt with.

(*d*) *Thana maps.*—Maps of 3 *thanas* of Backergunge district, of 5 *thanas* of Faridpur, of 4 *thanas* of north Bhágalpur, of 2 *thanas* of Purnea, of 9 *thanas* of Ranchi and of 4 *thanas* of Singhbhum have been prepared.*

(*e*) *Reproduction of village maps.*—During the season 3,793 sheets have been traced, 4,910 examined, and 656,407 copies despatched to Collectors and Settlement Officers; in 1904-05 239,082 copies were despatched, and in spite of this rapid increase the outturn has by no means yet reached its limit.

(*f*) *Badar Section.*—This section needs no comment.

(*g*) *Map Record Section.*—During the year 4,854 original sheets were received, making a grand total to date of 101,715 sheets; 16,102 paper traces were received, the total number of such traces now lodged being 37,624.

* Trijunction mark maps of 3 *thanas* of Backergunge, 6 of Tippera and 1 of Noakhali (Sarail and Chakla Roshnabad Estates), 10 of Darbhangha, 3 of North Monghyr, 4 of North Bhágalpur, 1 of Cuttack, 6 of Gaya and 2 of Patna (the work in the two last districts being made up from portions of scattered cadastral work) have been completed during the year.

UPPER AND LOWER BURMA.

No. 7 Party.

288. The party was transferred on the 16th October 1906 from the administrative control of the Deputy Surveyor General to that of the Superintendent in charge Burma Surveys.

Personnel.

Provincial Officers :

Mr. O. D. Smart in charge, Mr. C. G. Lee, Babu Jagdamba Prasad, Messrs. C. S Littlewood, S. F. Norman, and W. E. Swiney.

Subordinate Establishment:

17 Traversers, 13 Computers, 13 Draftsmen, 2 Typers, 5 Estimators, 6 Inspectors, and 45 Field Surveyors.

289. The programme consisted of the completion of the cadastral survey of the Pakôkku district, advance traversing in the Sinbaungwe township of the Thayetmyo district and the traverse and cadastral survey of part of the coast tracts of the Pyapôn district. The programme was completed with the exception of the cadastral survey of 14 square miles in Pyapôn which had, owing to heavy rain, to be postponed till next season.

290. The outturn and cost-rates were as follows :—

Locale.	Traversing.			Detail Survey.							Remarks.
	Kwins.	Square miles.	Cost per square mile including demarcation.	Kwins.	Sheets.	Fields.	Acres.	Square miles.	Cost per square mile.	Average size of fields in acres.	
			₹			(b)	(b)		₹	(a)	
Pakôkku (cadastral).	...	...	...	263	637	66,633	325,528	509	77	1·13	Scale 16 inches=1 mile.
Lower Chindwin (cadastral).	...	...	...	2	4	28	2,088	3	10		
Thayetmyo (cadastral).	335	691	66	20	49	6,857	28,050	44	158	0·76	
Pyapôn (cadastral) .	112	171*	186	107	234	31,706	80,108	125	205	1·2	
Pyapôn water area .	...	...	...	...	...	...	3,829	6			
Total Area .	447	862	...	392	924	105,224	439,603	687	...	...	

(a) Calculated on the cultivated area only.
(b) Includes jungle.
* Includes 26 square miles of jungle not for detail survey.

The cost-rates are all affected by the fact that there are no officers of the Imperial service with the party now. Those of traversing in Thayetmyo are ₹25 per square mile less than those for country of a similar nature in Pakôkku during the previous season.

In Pyapôn, although necessarily high, the rates both for traverse and cadastral survey compare very favourably as compared with work of a similar nature in Kyaukpyu in season 1902-03.

The cost-rates of cadastral survey in Pakôkku are ₹5 per square mile less than for last season's work in the same district ; in Thayetmyo the rates for cadastral survey are high owing to work having been taken up late in the season and the small area surveyed.

291. *Pakôkku.*—The cadastral survey of this district was commenced this season on the 10th November 1906 and completed on the 26th March 1907, when the section was transferred to Thayetmyo; the area surveyed lay in the Pauk and

Seikpyu townships and consisted of 107 square miles containing 60,516 fields of an average size of 1·15 acres. The remaining area of 402 square miles, consisting of hills and jungle, was not surveyed, but the traverse lines were provisionally accepted as *kwin* boundaries. The work was checked by 110 linear miles of test lines by the officers of the party and by 157 linear miles of independent *partals* by Inspectors, giving an average of 2·5 linear miles of check survey to each square mile cadastrally surveyed. The average number of *amins* employed was 38 for 118 days, and the average daily outturn per *amin* was 15 acres, comprising 14 fields. The origin of survey was the same as for the rest of the district, *viz.*, Latitude 21° 30′, Longitude 94° 30′. The health of the section while in the Pakkôku district was good.

292. *Lower Chindwin.*—Two jungle *kwins* adjoining the Pakôkku district which had been left out in previous years were surveyed cadastrally.

293. *Thayetmyo.*—The area to be traversed (691 square miles) lay in the Sinbaungwè and Minhla townships and was completed between the 6th November 1906 and 29th April 1907. It consisted chiefly of low hills covered with scrub jungle. The average number of traversers was 7 for 150 working days, and their average daily outturn was 12 angles and 124 chains.

No stations of the Great Trigonometrical Survey occurred in the area traversed, but the work was connected with seven trigonometrical stations of topographical series. The average linear error was 11·3 feet per mile. Double chaining was employed and totalled 1,625 linear miles. The theodolite was set up at 12,220 stations, of which 10,934 were new and were marked with galvanized iron cylinders at an average cost of twelve annas per station. Azimuths were observed at 78 stations and vertical angles at 2,677 stations. The origin of survey was Latitude 19° 30′ and Longitude 95° 15′.

The cadastral survey was commenced on the 29th March and closed on the 29th April 1907. The average number of *amins* employed was 17 for 30 days and the average daily outturn of each *amin* was 10 acres or 13 fields. The cultivated portion only were surveyed and amounted to 8 square miles, comprising 6,723 fields of an average size of 0·76 acres. The hilly and jungly area amounting to 36 square miles was not surveyed, but the traverse lines were accepted as *kwin* boundaries. The work was checked by 15 linear miles of test line by Provincial officers and by 9 miles of independent *partal* by Inspectors, giving an average check of 3 linear miles to each square mile surveyed.

Six cases of cholera occurred in this section at the beginning of the field season of which four proved fatal, but the health of the section was otherwise good. One *khalasi* was supposed to have been murdered, but no clue could be found by the Police.

294. *Pyapôn.*—The traverse survey of the area dealt with in the Pyapôn district commenced on the 17th December 1906 and was completed on the 20th of May 1907. The cadastral survey commenced on the 4th of February and closed on the 28th June 1907. The area surveyed lay in the Pyapôn and Bogale townships: it is situated in the delta of the Irrawaddy, intersected by tidal creeks and mostly subject to inundation. The only means of communication was by the ordinary boats of the district called "*sampans.*" The average number of traversers was 8 and the average daily outturn was 7 angles and 67 chains, this small outturn being due to heavy jungle clearing, tidal difficulties and slow communications by country boats. No trigonometrical stations were connected with. Double chaining was employed and totalled 812 linear miles. The theodolite was set up at 6,357 stations of which 5,725 were new and marked with galvanized iron cylinders at an average cost of thirteen annas per station. Azimuths were observed at 44 stations. The origin of survey was Latitude 16° 45′ and Longitude 94° 45′.

The cadastral survey was carried out by an average of 17 *amins* and 3 Inspectors and the average number of working days was 89. The average daily outturn of each *amin* was 53 acres comprising 21 fields. The total area surveyed was 131 square miles, consisting of a land area of 125 and a water area of 6 square miles. It comprised 27,116 fields of an average size of 1·2 acres. The area was mapped with full topographical details. The work was tested

by 85 linear miles of test lines by Provincial officers and 153 miles by Inspectors, giving an average of 1·9 linear miles to every square mile.

The men of this section suffered severely from fever and bowel complaints, the average number of sick being 77 per mensem; two deaths occurred and 13 men were invalided during the field season.

295. The 16-inch maps of all the current season's work have been completed and all containing cultivation have been sent to Calcutta for reproduction, the originals of the remainder, comprising jungle land only, have been sent to the Deputy Commissioners for record. To meet the immediate requirements of the Settlement Commissioners and Director of Land Records traces of 43 *kwins* in Pakôkku and of 52 *kwins* in Pyapôn have been prepared.

296. All the 2-inch mapping in Pakôkku has been submitted for publication and the new material in Pyapôn will be added to the existing maps. The portion of the Thayetmyo district under cadastral survey having been recently topographically surveyed will not be mapped on the 2-inch scale.

297. Unpublished proofs of the Rangoon town added area have been supplied to the district and municipal authorities and the maps will be published after the boundary pillars, which had not been erected at the time of survey, have been added.

298. The traverse computations have been completed and 60 traverse charts have been prepared for press, 27 remaining in various stages of progress. On publication of these charts the original traverse computations will be made over to the district authorities for record and safe custody.

299. The programme for 1907-08 consists of the cadastral survey of 647 square miles in Pakôkku, 14 in Pyapôn, 175 in Pegu and 20 in Yamethin districts. The area for survey in the two last named districts has yet to be traversed.

300. The Government of Burma having decided that all the cultivated areas in the province which it considers of sufficient importance to require the services of an Imperial Survey party will have been completed by the end of next field season, it is proposed to break up the party in October 1908. The revenue surveys of the province will in future be carried out by local agency. The maps of the area surveyed by No. 7 Party will continue to be reproduced in Calcutta, but, after their publication is complete, future revenue maps will be reproduced in the local Lithographic Press.

301. The party was inspected during the field season by the Superintendent in charge Burma Surveys.

CANTONMENT SURVEYS.

No. 1 Section.

302. During the season under report, this section was employed on the survey of the cantonments in the Meerut and Lucknow divisions. Mr. J. McHatton, a retired officer of the Provincial service, remained in charge till the 21st June 1907, when he was obliged to tender his resignation owing to a serious accident, and Mr. F. S. Bell, Extra Assistant Superintendent, 4th grade, was placed in charge temporarily till the end of the season, when Mr. E. G. Little, also a retired officer of the Provincial service, relieved him.

303. The survey of 7 cantonments was completed:— Dalhousie, Delhi, Muttra, Lansdowne, Shahjahánpur, Sitapur and Dinapore. That of Ranikhet and Benares was almost completed and of Naini Tal, Almora and Landour was commenced. The maps of 8 cantonments:—Solon, Dagshai, Sabáthu, Kasauli, Jutogh, Bakloh, Dalhousie and Muttra were forwarded to the Trigonometrical

office for publication, and those of 7 were published, namely, Kohát, Campbellpore, Roorkee, Sabáthu, Solon, Dalhousie and Jutogh. The areas surveyed during the season and the cost-rates were—

	Acres.	Rupees per acre.
Triangulation	6,711	0·38
Traversing	17,272	0·28
Detail survey on 16-inch scale	16,787	0·74
„ „ 64 „ „	253	4·22
Mapping	6,495	0·29

The cost-rate of the season's work has thus been R5·9 an acre, the cost of the 64-inch field work alone being R4·2. The programme was not quite completed, owing to there being so many hill cantonments in which work cannot be done during the cold weather or the rains. The average daily outturn of 16-inch survey was 12 acres and that of the 64-inch, 1 acre.

304. Next season it is proposed to resume the survey of Abbottabad, Nowshera and Mardan, in which work was commenced last season but was suspended owing to projected additions to the cantonments. Almora, Naini Tal and Landour, which have all been commenced, will also be completed, it is hoped, and also Bannu. The Deputy Surveyor General inspected this section twice during the season.

SECTION NO. 2.

305. This section was formed temporarily in December 1905 for the survey of the cantonments in the Poona and Mhow divisions and remained in charge of Mr. L. J. Pocock, also a retired officer of the Provincial service. The survey of the 8 cantonments of Poona, Kirkee, Khandála, Purandhar, Baroda, Ahmedabad, Devláli and Ajmer was completed, and the maps of the first 6 were forwarded to the Trigonometrical office for publication. The survey of Nasirabad, Mount Abu, Neemuch and Ahmednagar was almost completed and that of Aurangabad, Jubbulpore and Mhow commenced. Next season all the cantonments in these two divisions should be completed, those remaining for survey, besides the three abovementioned, being Indore, Sehore and Pachmarhi. The bazaars of Secunderabad and Bolarum of the Secunderabad division will also be surveyed by this section on the scale of 50 feet to the inch and probably this will not be completed by the end of next season as there are 42 bazaars and the scale is very large.

306. The Deputy Surveyor General inspected this section at Poona in July 1907. The season's outturn and cost-rates are—

	Acres.	Rupees per acre.
Traversing	18,494	0·3
Detail survey on the 16-inch scale including mapping.	13,327	1·0
„ „ „ 64 „ „ „	581	9·3

In addition to the above, all the cantonments that were surveyed last season were contoured during the season under report. The average daily outturn of 16-inch survey was 17·8 acres and of 64-inch survey, 1·4 acre without contouring. With contouring the outturn was 10·3 acres on the 16-inch scale. The cost-rate of the 16-inch survey without contouring was Ro·5 per acre and of the 64-inch survey, R8·8.

SECTION NO. 3.

307. This section was also formed temporarily early in 1906 for the survey of certain cantonments in the Secunderabad division and has now been broken up as the survey of all the cantonments has been completed, with the exception of the bazaars of Secunderabad and Bolarum which will be done by No. 2 Section. The cantonments have been surveyed on the 12-inch scale and the bazaars on the 48-inch. The entire civil and military station of Bangalore was surveyed on the 16-inch scale and also the cantonment of Belgaum of the Poona

division. The five Sappers who were employed in this section last season were all recalled to their corps and cadastral surveyors engaged in their place.

308. The outturn for the season and cost-rates, including mapping, are—

	Acres.	Rupees.
Traversing	9,098	0·3
Detail survey on the 12-inch scale	3,573	1·0
" " " 16 "	11,113	
" " " 48 "	645	5·2
" " " 64 "	181	

The average outturn per working day was—

	Acres.
Traversing 17 stations and 50 chains	...
Detail survey on 12 and 16-inch scales	8·3
" " 48 and 64 "	1·6

The bazaars of Cannanore and Trichinopoly had not been demarcated when the section was broken up, though the attention of the Military authorities and Executive Engineers was repeatedly called to the necessity for demarcating them, the first intimation having been given in each case before the survey was commenced in April 1906. The same difficulty occurred in all the cantonments of this division, the demarcation of most of them having been carried out after the surveyors had left them, consequently none of the maps have been submitted for publication yet.

Summary of the outturn of work of the field parties during the year 1906-07.

TOPOGRAPHICAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Triangulation: Instrument used.	Triangulation: Diameter in inches.	Triangulation: Area in square miles.	Triangulation: Square miles to each point trigonometrically fixed.	Triangulation: Square miles to each height.	Triangulation: Minor: Stations fixed.	Triangulation: Minor: Triangular error in seconds.	Triangulation: Minor: Error per mile in feet.	Triangulation: Tertiary: Stations fixed.	Triangulation: Tertiary: Triangular error in seconds.	Triangulation: Tertiary: Error per mile in feet.	Triangulation: Intersected points: Number of points fixed.	Triangulation: Intersected points: Error per mile in feet.	Traverses: Area in square miles.	Traverses: Linear miles of new chaining.	Traverses: Number of stations at which the theodolite was set up.	Traverses: Angular error per station in seconds.	Traverses: Linear error per mile.	Detail Survey: Area in square miles.	Detail Survey: Plane table fixings per square mile.	Detail Survey: Linear miles of test lines.	Detail Survey: Number of in-situ test fixings.	Linear miles of Forest boundary traverse.
4	2	Berar and Central Provinces	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	148
	6	Bengal, 24 Parganas	...	...	...	...	...	...	...	...	...	...	...	...	...	638	677	2,547	0·2	0·1	638	...	...	...	...
	9	Northern Circle	...	...	...	...	...	...	...	...	...	...	...	...	...	80	...	...	...	...	(a) 258	75	118	...	...
	17	Bombay Forests	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	62	113	54	177	140
	19	Madras { Coimbatore	5 & 6	26	1·3	1·8	...	...	...	2	17	0·3	13	0·6	...	...	4,552	2·1	1·6	34	117	10	...	...
		Madras { S. Malabar, Ganjam, Trichinopoly.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	522	...	...	...	540	97	64	...	...
	20	Lower Burma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	51	800	38	...	500
2	1	Central Provinces, United Provinces and Central India Agency.	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	816	3,042	4·7	1·5	(a) 664 (b) 838 (c) 135 (d) 297	21 24 10 10	855	1,381	...
	2	Berar-Central Provinces	6	1,680	2·5	2·5	46	8·1	0·2	52	10·0	0·2	557	0·4	...	...	...	...	...	...	2,396	33	833	1,879	...
	4	Bengal-Monghyr	6	375	3·0	...	21	12·6	0·3	43	...	1·2	28	...	13	117	1,550	...	...		51	5	34	...	...
	6	Bengal-Khulna	5 & 6	...	...	...	...	...	...	...	...	...	...	...	353	1,105	4,757	0·2	0·1		953	...	...	...	...
	9	Northern Circle	5 & 6	1,897	1·9	1·9	26	4·7	0·3	72	7·0	0·2	(f)	(f)	...	...	...	...	...		258	36	102	...	...
	10	Upper Burma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	56	615	...	2·3	148	74	33	2,776	...
	12	Northern Circle	6	4,730	2·9	3·0	49	8·3	0·1	28	9·2	0·1	1,648	0·3	...	...	...	...	...		2,930	22	...	1,509	...
	14	" "	6	4,495	3·6	3·6	...	...	...	107	8·7	0·2	1,028	0·6	...	...	...	...	...		1,547	23	886	1,014	...
	17	Bombay and Central India	6 & 7	2,155	10·5	10·5	...	...	...	264	8·0	0·5	1,452	0·8	...	...	...	...	...		(a) 348 (c) 2,292	39 16	115 669	884 1,793	...
	18	Northern Circle	6	1,240	3·2	3·0	..	...	...	76	8·0	0·1	316	(f)	...	(b) 2,302	5,095	0·5	0·8		1,801	24	297	...	...
	19	Madras { Nilgiri, N. Malabar, Coimbatore	6 & 7	3,412	4·7	4·7	51	9·0	0·2	17	12·9	0·4	670	0·3	...	...	...	...	...		441 472 602	(g) 4 (g) 2 (g) 4	111 47 137	... ...	... ...
	20	Assam Sylhet and Tippera	8	187	39·4	39·4	2	3·3	...	...	...	...	2	...	...	1,801	6,365	2·7	2·1		...	...	...	...	...
		Burma { Pakôkku Hill Tracts, Lower Chindwin	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		1,546 (b) 17	61 34	595 10	... ...	... ...
		Northern Circle, Training	8	1,059	1·8	1·8	49	8·0	0·1	9	9·5	0·5	531	0·5	...	...	...	...	...		322	42	146	...	...
1½	11	Southern Shan States, Burma	6	1,781	4·6	4·5	...	...	...	21	12·0	0·2	374	0·4	...	...	...	...	...		1,612	11	417	...	...
1	3	Lower Burma	6	(f) 2,605	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	...	...	...	...	...		2,979	6	843	...	...
	10	Upper Burma	6	706	3·0	3·3	6	12·6	0·3	8	7·6	0·2	213	2·3	...	...	...	...	...		2,562	21	586	2,776	...
	19	Madras—Mysore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		(e) 45	...	...	...	...

(a) Resurvey.
(b) Supplementary Survey.
(c) Revision Survey of Forests.
(d) Do. of Contouring.
(e) Revision survey.
(f) Computation incomplete.
(g) Not including plane-table traverse stations.

Summary of the Outturn of work of the field parties during the year 1906-07.

CADASTRAL SURVEYS.

Scale of Survey inches = 1 mile.	Number of Party.	*Locale* of Operations.	Traversing. Instrument used. Diameter in inches.	Traversing. Area in square miles.	Traversing. Linear miles of new chaining.	Traversing. Number of stations at which the theodolite was set up.	Traversing. Angular error *per* station in seconds.	Traversing. Linear error *per mile*.	Detail Survey. Area in square miles.	Detail Survey. Linear miles of test lines.	Detail Survey. Number of villages.	Detail Survey. Number of fields.	Record-writing. Average size of fields in acres.	Record-writing. Area in square miles.	Record-writing. Number of villages.	Record-writing. Number of fields.
16	4	Bengal, Monghyr	5 & 6	1,190 (a)	3,283	15,284	0·6	0·03	1,307	4,636	1,151	9,36,429	0·86	1,307	1,151	9,36,429
		„ Monghyr hill block	...	...	117	1,550	...	...		...	39	6,239	15·97		39	6,239
		„ Patna	5 & 6	852 (b)	3,379	16,165	1·07	0·02	...	...	...	...	...	...	...	...
		„ Bhágalpur	...	...	...	...	...	...	375	1,238	204	2,45,167	0·99	538	207	3,37,697
	5	„ Ranchi	5 & 6	1,128	3,568	17,516	1·2	0·5	...	...	...	...	...	...	...	...
		„ Sonthal Parganas	5 & 6	807	3,293	14,997	2·1	0·4	...	...	...	...	...	...	...	...
		„ Singhbhum (Dalbhum)	5 & 6	601	2,082	13,410	1·3	0·8	...	...	...	...	...	...	...	...
		„ Puri (Chilka lake)	5 & 6	97	430	1,455	1·2	0·5	...	...	...	...	...	...	...	...
		„ Midnapore (Dalbhum)	5 & 6	15	96	507	2·2	0·9	...	...	...	...	...	...	...	...
		„ Udaipur boundary	6	...	59	318	0·4	0·2	...	...	...	...	...	...	...	...
	6	„ 24-Parganas (Sunderbans)	5 & 6	638	677	2,347	0·23	0·05	...	...	...	...	...	...	...	...
		„ Khulna do.	5 & 6	953	1,105	4,757	0·21	0·05	...	...	...	...	...	...	...	...
		Eastern Bengal, Jalpaiguri	5 & 6	1,022	3,902	26,143	1·8	0·2	...	...	...	...	...	...	...	...
		Miscellaneous	...	28	...	...	...	...	1	...	...	...	...	...	...	...
	7	Burma, Pakôkku	...	...	...	...	...	...	509	675	263	...	(c) 1·1	...	...	...
		„ Lower Chindwin	...	...	...	...	...	...	3		2	...	(c) 0·8	...	...	...
		„ Thayetmyo	5 & 6	691	1,62,432	12,220	1·6	0·6	44	79	20	...	(c) 1·2	...	...	...
		„ Pyapôn		171	812	6,357	1·6	0·5	131	590	107	...		...	...	...
		TOTAL	...	8,193	...	...	...	...	2,370	...	...	...	...	1,845	...	...

(a) Includes 3 square miles surveyed during previous season.
(b) Includes 22 square miles of Government Estates and Tikari villages.
(c) Calculated on cultivated area only.

SPECIAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Spirit Levelling Operations. Miles levelled over.	Spirit Levelling Operations. Trigonometrical stations connected with.	Traversing. Area in square miles.	Traversing. Linear miles of new chaining.	Traversing. Number of stations at which the theodolite was set up.	Detail Survey. Area in square miles.	Detail Survey. Linear miles of test lines.	Record writing. Number of fields.
...	25	Tidal and Levelling	(a)805	16	...	...	...	...	...	...
105·6	Detachment	Calcutta suburbs	...	...	...	...	...	...	...	83
32	Do.	Panchannagram	...	...	...	...	...	...	...	115
105·6	Do.	Port Commissioners' area	...	...	2	18	460	1·0	(b)	...
16	Do.	Cantonment Section No. I.—Meerut and Lucknow Divisions.	...	...	27	330	4,035	26·2	95	...
64		Do. do.	...	...				0·4		...
16	Do.	Cantonment Section No. II.—Poona and Mhow Divisions	...	...	29	295	3,078	20·8	90	...
64		Do. do.	...	...				0·9	15	...
12	Do.	Cantonment Section No. III.—Secunderabad Division	...	...	14	233	5,251	5·6	216	...
16		Do. do.	...	...				17·4		
48		Do. do.	...	...				1·0		
64		Do. do.	...	...				0·3		
		TOTAL	(a)805	...	72	876	...	73·6	...	...

(a) Double levelling.
(b) *In situ* testing.

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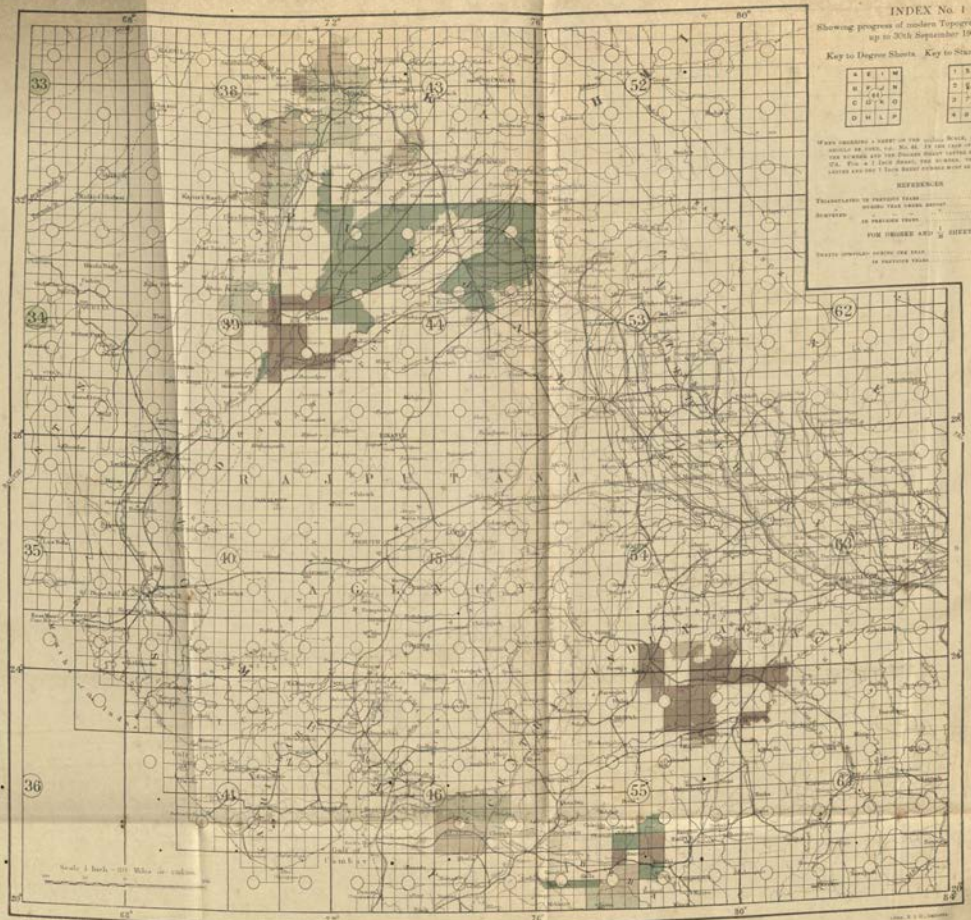
OF THE
ROYAL ASIATIC
SOCIETY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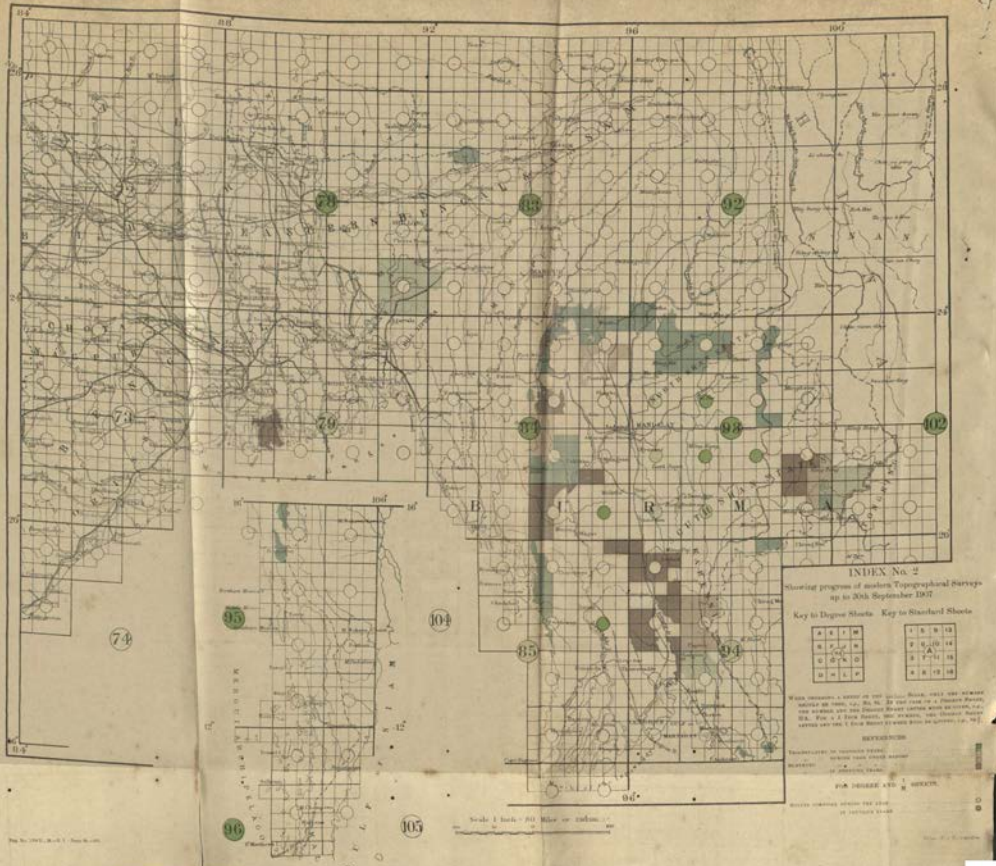
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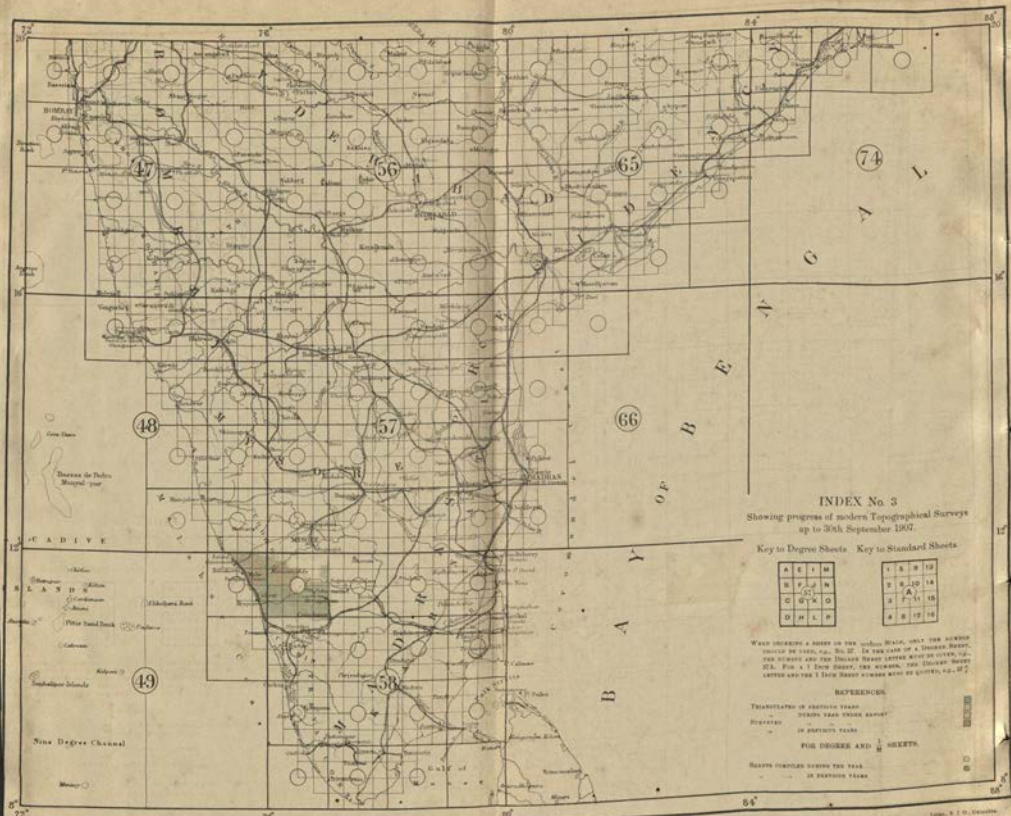
MANDALAY
SHAN
YUNNAN
SIAM
BENGAL
SEVENTH
FOR DEGREE AND 1/8 SHEETS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Reg. No. 458-S. 07.

INDIA
SHOWING STATIONS OF OBSERVATION
of the
MAGNETIC SURVEY.
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BENGAL
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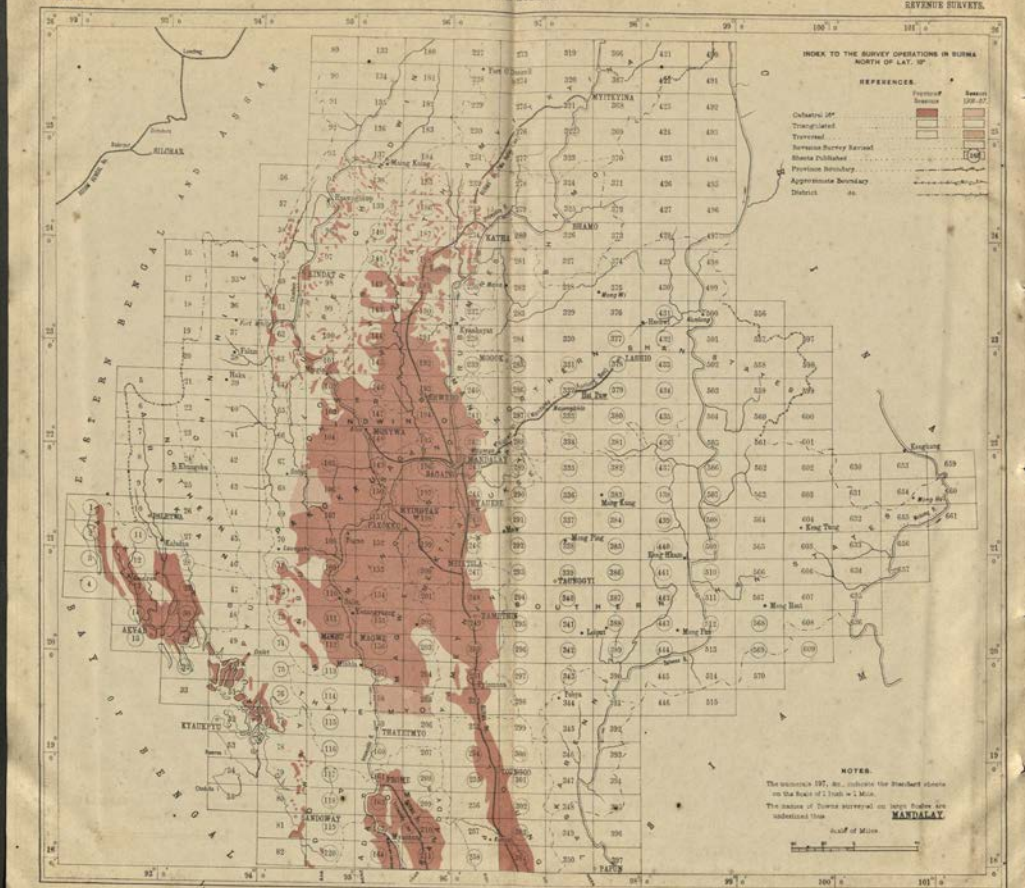
BURMA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Sheets Published
Province Boundary
Approximate Boundary
District do.
NOTES.
The numerals 197, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.
The names of Towns surveyed on large Scales are underlined thus MANDALAY
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BAY OF BENGAL
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KATHA
SHAMO
KINDAT
MONYWA
SAGAING
MINBU
MYINGYAN
MEIKTILA
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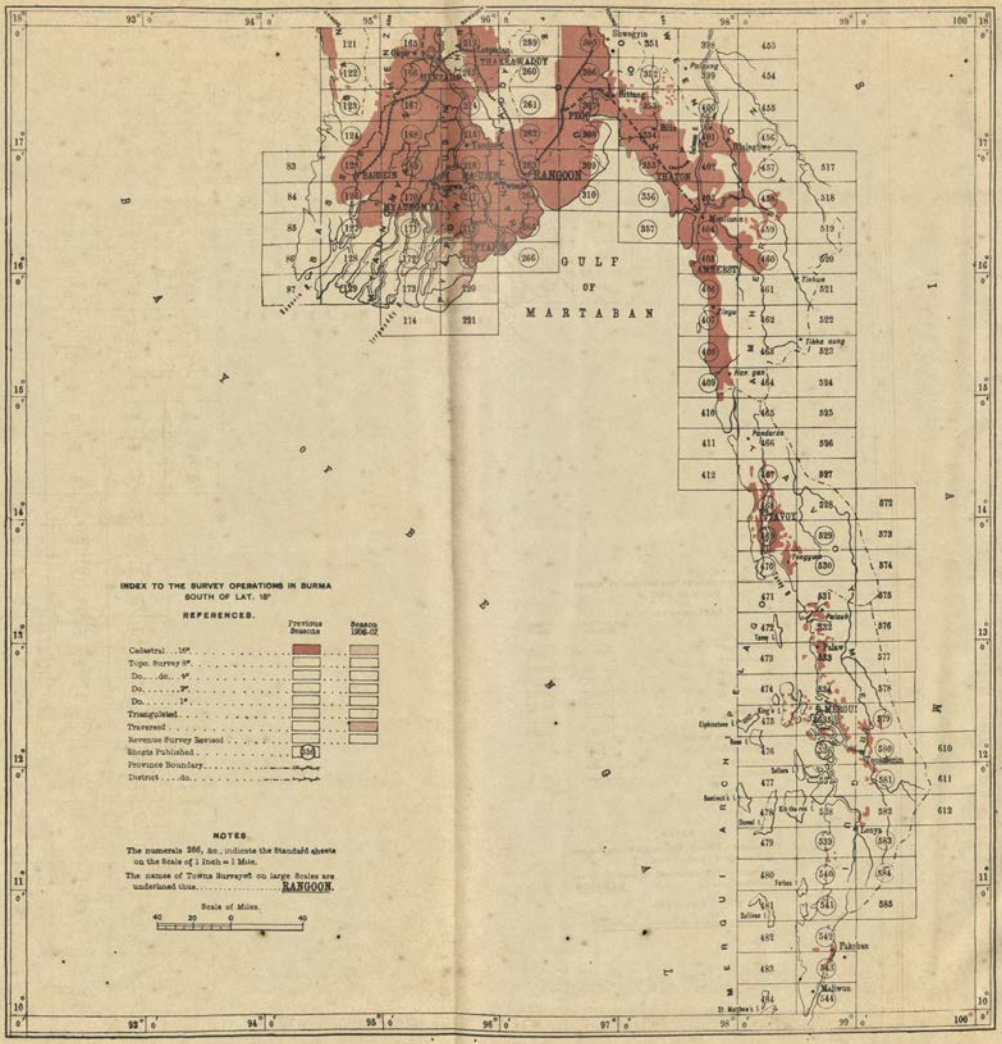
Myingyan
Monywa
Sagaing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District . . . do.
NOTES.
The numerals 266, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.
The names of Towns Surveyed on large Scales are underlined thus. . . . . RANGOON.
Scale of Miles.
40 20 0 40

Statement showing the cost-rate of work executed by the Field Parties during the year 1906-07.

Number of Party.	Name and *Locale* of field operations.	Cost rate per square mile. Triangulation.	Traversing.	Detail survey and preparation of maps on scales of 1"	1½"	2"	4"	Total cost for survey year ending 30th September 1907.
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹
1	Central Provinces, United Provinces and Central India Agency.	...	...	...	...	38·2 (*a*) (*b*) 25·7 (*a*) (*c*) 21·8 (*a*) (*d*)	...	94,874
	Berar, Central Provinces	13·2	...	...	...	41·0 (*e*)	...	75,737
3	Upper and Lower Burma	6·1	...	34·9	...	...	...	1,20,340
6	Bengal 24 Parganas (Sundarbans).	...	47·2	...	...	...	...	...
	Ditto ditto	...	28·8	...	...	...	...	...
	„ Khulna (Sundarbans)	...	58·2	...	...	...	...	...
	Ditto ditto	...	34·7	...	...	...	...	...
9	Northern Circle	13·1	...	...	...	40·2 (*a*)	73·8 (*a*) (*f*)	66,364
10	Upper Burma and Burma China Boundary.	19·5	13·6 23·1 (*g*)	39·8 30·3 (*c*) 12·2 (*d*)	...	54·1	...	1,04,337 (*h*)
11	Southern Shan States Upper Burma.	8·7	...	...	42·4	...	...	82,926
12	Northern Circle	8·8	...	...	...	53·6 (*a*)	...	1,20,742
14	„	7·2	...	...	...	39·8 (*a*)	...	1,11,977
17	Central India and Bombay	5·5	...	...	...	31·6 (*b*) 15·6 (*d*) (*e*)	65·8	77,940
18	Northern Circle	11·2	6·6 (*g*) (*i*)	...	...	31·8 (*a*)	...	
...	„ Shahpur	...	10·6 (*g*)	...	...	...	...	1,39,785
...	„ Bári Doáb	...	32·5 (*g*)	...	...	...	...	
19	Madras	5·5	13·8	4·4 (*d*)	...	45·1	91·5	1,26,591 (*j*)
20	Burma and Assam	38·5	20·5	...	...	65·5 26·1 (*c*)	305·7	1,72,456 (*k*)
...	Northern Circle, Training	...	...	...	...	...	...	37,973

(*a*) Exclusive of mapping.
(*b*) Resurvey.
(*c*) Supplementary survey.
(*d*) Revision survey.
(*e*) Includes special survey of forest boundaries.
(*f*) Inclusive of traverse.
(*g*) Rate *per* linear mile.
(*h*) Includes ₹2,227 on account of Burma China boundary.
(*i*) Traverse for supplementary survey.
(*j*) Includes ₹38,630 for forest Survey.
(*k*) Includes ₹17,116 for forest survey, ₹4,621 for 4" boundary survey and ₹1,584 publication charges.

CADASTRAL AND CANTONMENT SURVEYS.

Number of Party.	Nature and *Scales* of field operations.	Cost-rate per square mile. Traverse.	Detail survey and preparation of maps on scales of 12"	16"	48"	64"	Completion of vernacular records, etc.	Total cost of party inclusive of charges for instrument for local Governments.
	Cadastral Surveys.		₹	₹	₹	₹	₹	₹
4	Monghyr	35·9 (*a*)	..	53·0	...	...	52·0	2,59,125
	Patna	34·2 (*a*)	...	...	...	...	...	
	Bhágalpur	...	...	61·1	...	...	48·4	
5	Midnapore (Dalbhum)	24·8	...	...	...	...	...	82,550
	Ranchi	37·3	...	...	...	...	...	
	Singhbhum (Dalbhum)	30·4	...	...	...	...	...	
	Sonthal Parganas	26·6	...	...	...	...	...	
	Puri (Chilka Lake)	49·1	...	...	...	...	...	
6	Jalpaiguri	72·2	...	...	...	...	...	1,99,617
7	Pakôkku	...	...	77·0	...	...	...	1,81,115 (*e*)
	Lower Chindwin	...	...	10·0	...	...	...	
	Thayetmyo	66·0 (*b*)	...	158·0	...	...	...	
	Pyapôn	186·0 (*b*)	...	205·0	...	...	...	
Detachment.	Cantonment Section No. 1	0·3 (*d*)	...	1·0 (*d*)	...	4·5 (*d*)	...	22,943
„	„ „ No. 2	0·3 (*d*)	...	1·0 (*d*)	...	9·3 (*d*)	...	22,549
„	„ „ No. 3	0·3 (*d*)	1·0 (*d*)	1·0 (*d*)	5·2 (*d*)	5·2 (*d*)	...	22,884

(*a*) Includes cost of Monghyr triangulation.
(*b*) Includes cost of demarcation.
(*c*) Includes R1,010 cost of 800 galvanized iron sheets in stock which has been deducted in calculating the cost-rates.
(*d*) Cost per acre includes mapping.

APPENDIX.

Memorandum by Lieutenant-Colonel P. J. Gordon, I.A., on Forest Surveys in India.

(1) The Forest Survey Branch was created as a separate agency for Forest Surveys in 1872. The Branch was placed under the control of the Inspector General of Forests and Captain F. Bailey, R.E., then a Deputy Conservator of Forests in the North-West Provinces, was appointed Superintendent of Forest Surveys and Working plans.

Prior to the formation of this Branch it had been found that the ordinary small scale topographical maps were unsuitable for the purposes of forest administration, and it became necessary in many cases to supplement these maps by others on larger scales; these were produced by local or provincial agency but want of uniformity of scale and style impaired their use and, even when sufficient for local requirements, they were useless for geographical purposes, and their value was quite incommensurate with the cost of their production.

(2) From the outset the Government of India insisted on the necessity for placing the work of the Forest Survey Branch under competent professional supervision with a view to its field surveys being made suitable for incorporation into the standard maps of India.

To shew the importance attached to this supervision the following note regarding the formation of the Branch made by the Secretary to Government may be quoted: " . . . the Branch so far as its pure surveying work is concerned must work strictly and absolutely in accordance with the rules of the Imperial Survey Department and be subject, in all matters of professional detail, to the guidance of the Surveyor General in such wise as to satisfy him that he may safely accept in his own maps the geographical details furnished to him (at such time and in such form as he may prescribe) by the Forest Surveys. I consider this of such importance that I cannot now move further in the matter until the papers have been laid before Colonel Thuillier and Captain Bailey shall have satisfied him that in all these respects everything will be done entirely to his satisfaction."

In 1873 the Duke of Argyll, then Secretary of State for India, while approving of the formation of a Forest Survey Branch remarked on the importance of connecting Forest Surveys with those under the Surveyor General in order that they might be capable of reduction and of being used for geographical purposes. With this object in view Colonel Walker, R.E., F.R.S., Superintendent of Trigonometrical Surveys, was asked by the Government of India to assist and advise in the work. Captain Bailey repeatedly acknowledged the great benefit he had derived in organizing the Branch and in carrying out its operations, from Colonel Walker's assistance and advice which were at all times readily afforded. In 1876 the Marquis of Salisbury, then Secretary of State, in the course of a despatch on the subject, noticed with satisfaction that the co-operation of the Superintendent of the Great Trigonometrical Survey in the work executed, had been of value.

Colonel Walker, in submitting the annual progress report of the Forest Survey Branch for 1876-1877 to the Government of India, placed on record that the maps produced by the Branch were well suited for reduction and incorporation into the standard map of India on the scale of one inch = one mile executed by the professional Survey Department. He also remarked that the principal object which was originally contemplated had been satisfactorily accomplished.

In 1878 Colonel Walker was appointed Surveyor General and the Government of India requested him to exercise, as Surveyor General, the same professional supervision as he had hitherto exercised as Superintendent of the Great Trigonometrical Survey.

(3) The annual progress report of the Forest Survey Branch was until 1877 submitted to the Government of India by the Superintendent, Great Trigonometrical Survey, and from 1878 to 1893 by the Surveyor General. From 1894 the report on the operations of the Forest Survey Branch was incorporated in the General Report of the Survey of India and has continued to be so incorporated up to the present time. The Superintendent of Forest Surveys continued however to submit a special report giving a more detailed account of the work which was published annually.

(4) In the early years of its existence the Head-Quarters of the Forest Survey Branch was located in various private houses hired as offices. It was soon realised that this arrangement was unsuitable and Dr. Brandis, then Inspector General of Forests, writing in 1875 remarked: " It is essential that all original maps and records be kept permanently in one place guarded from risk of fire and insects and that they should be kept in systematic order so as to be readily accessible. . . for this purpose a permanent Forest Survey Office is necessary. . . . eventually it may be an advantage to build an office in the vicinity of the Great Trigonometrical Office."

This hope was not realized until 1903 when the present office was built in the compound of the Great Trigonometrical Survey office at Dehra Dún.

(5) From the commencement the rules regarding the apportionment of the cost of Forest Surveys were somewhat complicated. In 1888 the Government of India laid down

definite rules whereby a certain proportion of the cost of Forest Surveys executed by the Survey of India should be borne, in respect of the value of the work for topographical purposes, by the Survey of India and the balance by the Forest Department. The proportion was regulated by the proportion of Forest area, the whole area under survey by a party, and also by the scale of survey. These orders were amended on various occasions until finally in 1904 one uniform rule was applied to the whole of India whereby 70 per cent. of the cost of Forest Surveys was to be borne by the Forest Department and 30 per cent. by the Survey of India.

(6) The necessity for good maps for general Forest administrative purposes and more especially for the preparation of working plans is fully recognized in all countries where the management of State Forest is carried out on scientific principles. The question of the most suitable scale for Forest maps has always been one on which there has existed a great difference of opinion. In Europe Forest maps are prepared on very large scales, but the case is not on parallel lines with that of India, as in Europe the maps are almost solely used as legal documents in connection with the record of the boundaries and not, as in India, for working the forests. When the Forest Survey Branch was organized Conservators of Forests were consulted as to what scale should be adopted: their opinion differed widely: the 4-inch, 8-inch, and the 16-inch all had their supporters, but on the whole the 8-inch was the scale preferred by most of those consulted.

There were, however, many objections to this scale being adopted, such as the enormous cost of the survey and the unwieldiness of the maps, and it was finally decided, with the approval of the Superintendent, Trigonometrical Surveys, to adopt the 4-inch scale and this scale, with certain exceptions, became the standard scale for Forest Surveys in India. This decision is upheld by the late Mr. D'Arcy who, in his "Notes on the preparations of working plans" published in Calcutta in 1892, states that a scale of 4 inches to a mile is the largest that is generally required in India. The 16-inch scale was adopted for *babul* forests of small area in the Deccan and the 8-inch for the Teak Forests of the Konkan where the intensity of the working required maps showing all possible detail with the greatest accuracy. In both these instances the value of the forests justified the expenditure. In the Thana district of Bombay a 4-inch survey which was made between 1881-1885 was found inadequate and a survey on the 8-inch scale which has just been completed was demanded.

(7) In several instances it was thought that a mere boundary survey would serve the purposes of Forest administration but such surveys have almost invariably had to be replaced by detail surveys. Such boundary surveys are principally useful in checking encroachments, and in the Central Provinces most of the Forest Surveys have been supplemented by an additional boundary survey on the 16-inch scale for comparison with village maps.

(8) The training of Forest Officers in survey work was part of the original scheme for a Forest Survey Branch and during the early years of its existence many Officers of the Forest Department were attached to the Branch. In 1878 the Forest School was established at Dehra Dún and Captain Bailey was appointed its first Director in addition to his other duties as Superintendent of Forest Surveys; as his duties as Director occupied most of his time much of the work in connection with the supervision of the Forest Survey Branch devolved on his Assistant, Mr. W. H. Reynolds, who was eventually in 1883 appointed to succeed him as Superintendent. Mr. Reynolds continued in charge until 1900 when on his retirement he was succeeded by Captain P. J. Gordon, I. A., Deputy Superintendent, Survey of India, who continued to hold the appointment until the Forest Survey Branch ceased to exist on the 15th October 1906.

(9) On the 1st April 1899, No. 20 Party, Survey of India, which had been employed on Forest Surveys in Burma was amalgamated with the Forest Survey Branch, and the Branch, which had hitherto been under the administrative orders of the Inspector General of Forests, came under the general and professional control of the Surveyor General.

On the 1st April 1904, the Governments of Madras and Bombay having accepted the suggestion of the Government of India that the Forest Surveys in these Presidencies should come under the supervision and professional control of the Superintendent, Forest Surveys, the Branch was reconstituted under the designation of the Forest Survey Branch of the Survey of India and all its establishment reverted or was transferred to the Survey of India. The expenditure on Forest Surveys throughout India was by the same resolution distributed in a uniform manner, 30 per cent. to Topographical Surveys in consideration of the value of the work in the preparation of standard maps, and 70 per cent. to Forests.

(10) The Branch as reconstituted consisted of No. 9 Party employed in detachments in various parts of India, where there was not sufficient Forest Survey work for a complete party, No. 17 Party in the Bombay Presidency, No. 19 Party in Madras and No. 20 Party in Burma. The Drawing and Map Record and Issue Office continued as before at the Head-Quarters of the Branch at Dehra Dún.

(11) In 1904 the Indian Survey Committee, appointed to consider among other matters, the methods and expenses of surveys and the organization of the Department, recommended that special Forest Surveys should cease as a general rule, and, where required on scales larger than those of the regular Topographical, their cost should be debited to the Forest Department.

This recommendation being in conformity with the views of the Surveyor General and of the Inspector General of Forests, it was decided that the various parties constituting the

Forest Survey Branch should be absorbed and employed for the future on Topographical Surveys.

On the 15th October 1906 the post of Superintendent of Forest Surveys, in accordance with another of the recommendations of the Committee, lapsed, and the Forest Map Record and Issue and Drawing Offices were placed under the charge of Mr. C. F. Erskine, Deputy Superintendent, Survey of India.

(12) In the future it is proposed that all Forests occurring in sheets coming within the regular programme of the Survey of India shall be surveyed either on the scale adopted for the sheet or, if required, on any other scale up to two inches=one mile, and also that, when required, an additional boundary survey of such Forests on the 4-inch scale shall be made without any extra charge to the Forest Department, but that, when any surveys are required outside the regular programme of the Survey of India, or on scales larger than 2 inches=1 mile the cost of such surveys shall be paid for entirely by the Forest Department.

(13) Among Officers who have been intimately connected with the Forest Survey Branch the following may be mentioned in addition to the Superintendents already referred to:—

Mr. H. C. Hill, afterwards Inspector General of Forests, who was attached to the Branch from 1874 to 1878.

Mr. E. F. Litchfield, Deputy Superintendent, Survey of India, who was attached from 1875 to 1895.

Mr. Chill, who belonged to the Branch from its formation until his death in 1888; Messrs. T. S. Marten, J. Marten, Hughes, Nichol and C. Litchfield of the Survey of India were all employed for long periods.

This record would not be complete without more than a passing reference to Mr. A. Descubes who joined the Branch in 1887 and was soon afterwards appointed Superintendent of Forest map records. The care and up-keep of the map records of the Forest Department has been under his charge since he joined and most of the working plan and other special maps of the Forest Department which have been published have been compiled and prepared by him.

Among the subordinates the Head Clerk, Babu Kalikanth Kar, the Head Computor, Babu Badri Dutt, and Surveyors, Fulsi Ram, Odey Singh and Bhup Singh Bist, who have spent their whole service in the Branch, deserve special notice.

(14) 68,424 square miles of Forests or nearly two-thirds of the total area of reserved forests in India have now been surveyed on the 4-inch or larger scales: much of the remaining area consists of forests the value of which is not considered sufficient to justify the expense of a special survey.

(15) The first survey undertaken by the Forest Survey Branch was that of the Forests of Dehra Dún on the 4-inch scale, the survey of the plains portion being carried out during the same period by the Survey of India: this Survey was conducted on ideal lines as both departments worked in close connection with one another each confining its operations to its own legitimate sphere: the principal object which was originally contemplated in associating the Forest Surveys with the Trigonometrical Surveys was here most satisfactorily fulfilled and the resulting maps although prepared over thirty years ago still answer their purpose. Until 1879 the operations of the Forest Survey Branch were almost entirely confined to the United Provinces and Oudh, but from that year until the present time its operations have extended to every Province in India.

Various Revenue and Topographical parties of the Survey of India have also been employed since 1878 on Forest Surveys in the Punjab, United Provinces, Bengal, the Central Provinces, Burma, and in the Madras and Bombay Presidencies.

(16) The following table gives in detail the Forest areas surveyed in various forest divisions on the 4-inch and larger scales:—

Detail survey on 4-inch scale and larger scales of Forest Reserves on 30th September 1900.

Province.	Circle.	Area surveyed up to 30th September 1906.
		Sq. miles.
Bengal	Bengal	2,563
United Provinces of Agra and Oudh	Eastern Circle	2,050
	Western Circle	1,999
	TOTAL	4,049
	Carried over	6,612

Detail survey on 4-inch scale and larger scales of Forest Reserves on 30th September 1906—contd.

Province.	Circle.	Area surveyed up to 30th September 1906.
		Sq. miles.
	Brought forward	6,612
Punjab	Punjab	3,398
	Jubal-Taroch	170
North-West Frontier Province	North-West Frontier	366
Central Provinces	Northern Circle	7,788
	Southern Circle	7,268
	Berar Circle	3,142·5
	TOTAL	18,198·5
Burma	Northern Circle	3,210
	Southern Circle	3,061
	Tenasserim Circle	3,213
	Pegu Circle	2,918
	TOTAL	12,402
Eastern Bengal and Assam	Eastern Bengal and Assam	985
Ajmer-Merwara	Ajmer-Merwara	142
Madras	Northern Circle	4,110
	Southern Circle	5,171
	Central Circle	5,347
	TOTAL	14,628
Bombay	Northern Circle	2,345
	Southern Circle	4,671
	Central Circle	4,507
	Sind Circle	...
	TOTAL	11,523
	GRAND TOTAL	68,424·5

(17) Attempts have been made in different Provinces to utilize the services of the surveyors for the purpose of keeping up a record of soils and forest growth, but owing to the want of expert knowledge on the part of the men, such records have proved of little value.

(18) A critical examination of the cost-rates of forest surveys in different Provinces and by the various agencies would be out of place here; nor would it serve any useful purpose. The cost-rates are influenced by so many considerations outside the actual professional work of the surveyor that comparisons would be misleading.

Forest maps are issued free of cost to Government Departments: each edition consists of from 50 to 100 copies and as each edition is exhausted a new edition embodying all changes in boundaries is published. The maps are available for sale to the general public but there is little demand for them.

CALCUTTA: PRINTED BY SUPDT. GOVT. PRINTING, INDIA, 8, HASTINGS STREET.

Half-tone. Survey of India Offices, Calcutta 1909.

CHECKING A PLANE-TABLE.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1907-08

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E.,

SURVEYOR GENERAL OF INDIA

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1909

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BAY OF BENGAL
INDEX CHART
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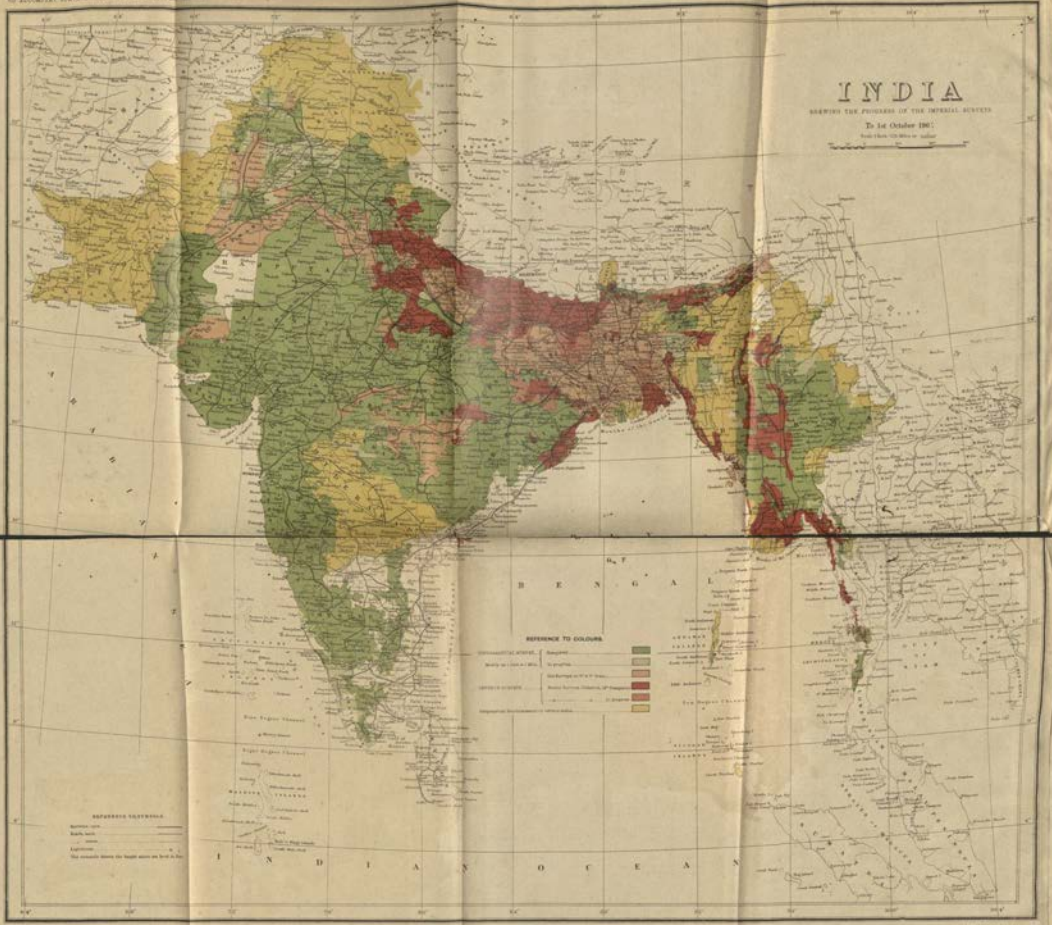
INDIA
SHEWING THE PROGRESS OF THE IMPERIAL SURVEYS
To 1st October 1867
REFERENCE TO COLOURS
BENGAL
INDIAN OCEAN

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1907-1908.

PART I.

SUMMARY.

ADMINISTRATION.

1. This report deals with the operations of the department for the year ending the 30th September 1908.

Colonel F. B. Longe, R E., administered the department throughout the year, except from 28th February to 24th September 1908, when he proceeded on combined leave to Europe. During his absence, Colonel S. G. Burrard, R.E., F.R.S., Superintendent, Trigonometrical Surveys, officiated for him, and Mr. J. Eccles, M.A., officiated for Colonel Burrard. Mr. Eccles also officiated for Colonel Burrard as Superintendent, Trigonometrical Surveys, from 1st October 1907 to 10th November 1907. Colonel G. B. Hodgson, I.A., continued to hold his appointment of Deputy Surveyor General. Lieutenant-Colonel P. J. Gordon, I.A., and Major C. H. D. Ryder, D.S.O., R.E., held the appointments of Superintendents, Burma Surveys, and of the Northern Circle, respectively, throughout the year. Captain F. C. Hirst, I.A., officiated as Superintendent, Provincial Surveys, Bengal, for Major Crichton, I.A., who was on furlough.

2. In March 1908, the property known as Castle Hill estate at Mussooree was purchased by Government, for the accommodation of the topographical parties and offices under the Superintendent, Northern Circle, and such of the trigonometrical parties as recess at Mussooree. It covers an area of about 182 acres and there are 8 houses of various sizes on it, besides a very large number of out-offices. It has also suitable sites for building, but the present houses, when necessary alterations are made to adapt them for survey offices, will, it is hoped, meet the immediate requirements of this department. It will, however, be necessary to build later on when money is available, as several of the houses are not really suitable for permanent offices, and it will probably be found more convenient and economical to rent them as dwelling-houses to members of the department.

Inspection Tours of Administrative Officers.

3. Colonel F. B. Longe, R.E., Surveyor General, left Simla on the 29th October 1907 and visited Roorkee and Dehra Dún, arriving at Calcutta on the 15th November. At Dehra Dún he inspected the office of the Superintendent, Trigonometrical Surveys and the Forest Map office. On the 28th February he proceeded on combined leave.

On the 25th September 1908 he returned from furlough, and on the following day, he left Bombay for Bangalore.

It had been intended to hold the annual conference of senior officers at Bangalore, this year, but owing to Colonel Burrard's indisposition, this was not possible. All the points, however, that would have come before it, were discussed by the Surveyor General with Colonel Hodgson and Lieutenant-Colonel Gordon

at Bangalore and later on with Colonel Burrard and Majors Ryder and Coldstream, at Mussooree.

The main points considered were as follows :—

(*a*) The classification of surveyors throughout the department as a whole, their pay, rules of service, etc.

(*b*) Means for insuring uniformity in the method of showing past and proposed surveys on index maps.

(*c*) The progress made in the style of mapping and the improvements that should be introduced in the matter of lettering and ornamentation.

(*d*) The transfer of all triangulation to the Trigonometrical Branch.

A satisfactory scheme has, it is hoped, been drawn up on the first subject. It may be roughly described as follows :—

There will be three classes of surveyors, who will be recruited and trained as pupils for two years before being classed. They will then be on probation for two more years, after which, they will be appointed surveyors :—

	R
The pay of the 1st class will be	30—5—100
" " " " 2nd " " "	25—3—60
" " " " 3rd " " "	20—2—45

the increments being biennial.

It is hoped, that gradually the third class will die out, as the class of recruit improves— as no doubt it will—and that no men will be retained in the service who are not worthy of being placed into classes 1 or 2.

During his stay at Bangalore the Surveyor General inspected the offices of Nos. 3, 10, 11, 19 and 20 Parties and the circle drawing office. The whole of the work and arrangements showed great improvement, and indicate that all classes are working most creditably, and with a little more experience, the fair mapping will leave little to be desired.

4. Bt.-Colonel S. G. Burrard, R.E., Officiating Surveyor General of India, left Calcutta for Dehra Dún on 4th and arrived there on 6th April 1908. He inspected the Trigonometrical Survey office and Forest Map office at Dehra Dún, and then proceeded to Mussooree, where he inspected the Castle Hill estate, which had been purchased by the Government, to provide office accommodation for the parties of the Survey of India recessing at Mussooree. From Mussooree, he returned to Dehra Dún and conferred with the Superintendent, Trigonometrical Surveys, and the Castle Hill estate committee, regarding the future management of the estate. He left for Simla on the 29th April, arriving there on the 30th.

He left Simla on 8th September 1908 and arrived at Dehra Dún on the 9th ; after conferring with the Superintendent, Trigonometrical Surveys, he left for Mussooree, where he inspected the Frontier and other Drawing offices and the offices of the several field parties both of the Northern Circle and of the Trigonometrical Branch.

5. Colonel G. B. Hodgson, I.A., Deputy Surveyor General, inspected the United Provinces drawing office at Naini Tál during October 1907. Proceeding from Calcutta in December, he inspected in the field Nos. 1, 2, and 17 Parties and also the two cantonment sections, returning the same month. In January, he inspected at Jubbulpore, the survey of cantonments then in progress. In July, he went from Calcutta to Pachmarhi, and inspected No. 2 cantonment section, and from there proceeded to Poona, where he inspected in recess, Nos. 1, 2, and 17 Parties, remaining there till the end of August.

6. Mr. J. Eccles, M. A., officiating Superintendent, Trigonometrical Surveys, visited Mussooree in June, July and September 1908, and inspected the recess offices of Nos. 22, 23, 24, and 26 Parties. He also inspected at Dehra Dún, in September 1908, the Forest Map office, No. 25 Party (Tidal and Levelling), and also the Survey Training school during the year from time to time.

7. Lieutenant-Colonel P. J. Gordon, I.A., Superintendent in charge Burma Surveys, was present at a conference held in Shillong, in November 1907, for the purpose of discussing the programme of topographical surveys in Assam, and the question of the offices for the Eastern Circle at Shillong, at which the Lieutenant-Governor of Eastern Bengal and Assam, the Chief Secretary, the

Director of Land Records, and the Superintendent, Provincial Surveys, Bengal, were present. He inspected No. 19 Party in the field in Malabar in December 1907 and again in the Wynaad in April 1908. During January and February he inspected Nos. 3, 7, and 10 Parties in the field in Burma and No. 20 Party in Assam.

8. Major C. H. D. Ryder, D.S.O., R.E., Superintendent, Northern Circle, proceeded to Quetta during September 1907, and returned to his head-quarters at Mussooree, on the 3rd October 1907. In the beginning of November his head-quarters office was moved to Dehra Dún. He left Dehra Dún to inspect his field parties on the 7th December and returned to his head-quarters at Dehra Dún on the 25th idem. He again proceeded to the field on 1st February and returned to Dehra Dún on 7th idem. He proceeded to inspect all his parties on the 11th February, and returned to Dehra Dún on 7th March 1908. He left Dehra Dún for Dera Gházi Khan and Dera Ismail Khan to inspect Nos. 9 and 18 Parties on 26th March and returned to Dehra Dún on 5th April. In April his head-quarters office was again moved to Mussooree. He left for Peshawar to inspect No. 12 Party on the 19th April and returned to his head-quarters at Mussooree on 11th May. He inspected the Training Party at Dehra Dún on the 23rd July and proceeded to Quetta on 31st August and returned to Mussooree on 13th September. He inspected the Simla Drawing office the same month and returned to Mussooree on 13th October 1908.

9. Captain F. C. Hirst, I.A., officiating Superintendent, Provincial Surveys, Bengal, inspected each section working under him at least once in the field season and again during a monsoon tour. He also inspected the mapping of several Settlement offices in Bengal and Eastern Bengal.

DISTRIBUTION OF FIELD PARTIES.

10. Field operations were carried out by 22 parties and 3 sections or detachments. Of the parties, 13 were employed on topographical surveys, 1 on principal triangulation, 4 on purely scientific operations, 1 on traverse surveys for cadastral purposes, 1 on traverse and cadastral surveys, and 2 on traverse and topographical surveys. The following table shows the distribution according to the nature of the work on which the parties were employed.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale.	Administrative Superintendent.
	TRIGONOMETRICAL.				
24	India	23	Captain C. M. Browne, D.S.O., R.E.	...	S. T. S.
	SCIENTIFIC.				
22	India (Latitudes) . .	25	Captain H. M. Cowie, R.E. .	...	S. T. S.
23	„ (Pendulums) .	27	Major G. P. Lenox-Conyngham, R.E. Captain H. M. Cowie, R.E. .	...	Ditto.
25	„ (Tidal and Levelling).	29	Mr. C. F. Erskine . . .	...	Ditto.
26	„ (Magnetic) . .	32	Captain R. H. Thomas, R.E. . Lieutenant H. J. Couchman, R.E.	...	Ditto.
	TOPOGRAPHICAL.				
1	Central and United Provinces and Central India States.	37	Lieutenant M. N. Macleod, R.E. „ K. W. Pye, R.E. .	2″=1 M. 1″=1 M.	D. S. G.
2	Berar	38	Captain H. Wood, R.E. .	2″=1 M. 1″=1 M.	Ditto.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale.	Administrative Superintendent.
	TOPOGRAPHICAL—*contd.*				
17	Bombay Presidency	39	Mr. B. G. Gilbert-Cooper Mr. S. F. Norman (senior)	2″=1 M.	D. S. G.
3	Burma	41	Captain C. P. Gunter, R.E.	2″=1 M. 1″=1 M.	Supdt., Burma Surveys.
10	„	42	Captain A. A. McHarg, R.E.	4″=1 M. 2″=1 M. 1″=1 M.	Ditto.
11	Shan States	44	Captain R. H. Phillimore, R.E.	1⅓″=1 M.	Ditto.
19	Madras	45	Captain F. F. Hunter, I.A.	4″=1 M. 2″=1 M. 1″=1 M.	
20	Eastern Bengal and Assam	47	Major A. Mears, I.A.	2″=1 M. 1″=1 M.	Ditto.
9	Northern Circle	48	Lieutenant E. C. Baker, R.E. „ F. J. M. King, R.E.	2″=1 M. 1″=1 M.	Supdt., Northern Circle.
12	„ „	49	Brevet-Major E. T. Rich, R.E.	2″=1 M.	Ditto.
14	„ „	50	Captain H. L. Crosthwait, R.E. Lieutenant V. R. Cotter, I.A.	2″=1 M.	Ditto.
18	„ „	51	Captain E. A. Tandy, R.E.	2″=1 M. 1″=1 M.	Ditto.
Training	„ „	52	Mr. G. P. Tate	2″=1 M.	Ditto.
„	Burma Surveys detachment.	46	Mr. G. T. Hall	2″=1 M.	Supdt., Burma Surveys.
	CADASTRAL AND TRAVERSE.				
4	Bengal	52	Mr. N. Bedford	16″=1 M. 2″=1 M.	S. P. S., Bengal.
5	„	53	Mr. C. S. Kraal	16″=1 M.	Ditto.
6	Eastern Bengal	54	Mr. A. W. Smart	16″=1 M. 2″=1 M.	Ditto.
7	Burma	55	Mr. O. D. Smart	16″=1 M.	Supdt., Burma Surveys.
Section No.	CANTONMENT SURVEYS.				
1	Peshāwar, Meerut, and Lucknow Divisions.	57	Mr. E. G. Little	16″=1 M. 64″=1 M.	D. S. G.
2	Poona and Mhow Divisions.	58	Mr. L. J. Pocock	16″=1 M. 64″=1 M. 105·6″=1 M.	Ditto.

TRIGONOMETRICAL SURVEYS.

11. The triangulation party (No. 24) was divided into three detachments; of these, one worked in western Baluchistán, one in Burma, and one in northern Baluchistán.

(*a*) In western Baluchistán, the Kalát longitudinal series was completed up to the point of trijunction of Baluchistán, Persia, and Afghánistán (Koh-i-Malik Siah, longitude 60° 54′); a length of 107 miles. Thirteen triangles were observed covering an area of 2,375 square miles, the average triangular error being 0·35″.

(*b*) In Burma, the Great Salween series was continued eastwards to longitude 98° 42′, a length of 55 miles. Fourteen triangles were observed covering an area of 1,800 square miles, with an average triangular error of 0·64″.

(*c*) In northern Baluchistán, the selection of the stations was carried from Kalát *viâ* Quetta and Pishīn into Zhōb.

SCIENTIFIC AND SPECIAL OPERATIONS.

12. Major G. P. Lenox-Conyngham, R.E., and Captain H. M. Cowie, R.E., were employed in the continuation of the gravimetric survey. Captain Cowie took observations for latitude, to determine the deflection of plumb-line, at six stations near Deesa, with the object of investigating the variations in the density of the earth's crust, that have been discovered in this region.

13. Major Lenox-Conyngham took pendulum observations at eight stations in Southern India, with the object of ascertaining whether the structure of mountains in the peninsula resembled the structure of the Himalaya.

14. Major Lenox-Conyngham observed his pendulums both at the top and at the bottom of the Edgar shaft of the Mysore mine. His two pendulum stations were in the same vertical line, and were separated by a vertical distance of 2,617 feet. His results here furnish data from which a new value of the mean density of the earth can be deduced, but it has not as yet been decided how to utilise the data.

In view of the employment in the near future of a new 4-metre invar bar as the survey standard in place of Colonel Everest's old standard 10 feet bar A, it was deemed advisable to send the latter to Europe for comparison with the International Metre at Sèvres. Before the bar left Dehra Dún for France, it was carefully-compared against the secondary standard bars I_B and I_S by Major Lenox-Conyngham and Captain Cowie.

15. Tidal operations were continued by No. 25 Party, observations being recorded at the eight permanent stations. The new observatory at Moulmein was constructed.

16. Levelling operations were carried out by three separate detachments. The revision of the line of levels from Bombay to Madras was completed, and new lines were taken through the southern Punjab and Rajputana. Six new standard bench-marks were connected.

17. The preliminary magnetic survey was completed with the exception of (*a*) the coast of Burma, (*b*) the wild country north of Burma, and (*c*) the Himalayan-Karakoram regions. This was the first year that the magnetic base-stations have worked throughout with their now complete instrumental equipments. The detailed magnetic survey is about to be commenced.

18. The following statement shows the cost of the more purely scientific work of the department for the survey year under report :—

			Cost. ₹
Field Parties, No. 22 Party,	Astronomical		21,343
„ „ „ 23 „	Pendulums		33,691
„ „ „ 24 „	Triangulation		1,83,680
„ „ „ 25 „	Tidal and Levelling—		
		₹	
	Tidal observations	14,627	
	Preparation of Tide Tables.	26,669	
	Levelling operations	44,891	
			86,187
„ „ „ 26 „	Magnetic—		
	Magnetic observatories.	13,423	
	Magnetic field work	74,959	
			88,382
	TOTAL		4,13,283
Controlling and Administrative staff	Trigonometrical	63,569	
Trigonometrical Branch Office		1,59,874	
			2,23,443
	GRAND TOTAL		6,36,726
			₹
Last year the cost of the field parties was			2,89,999
Controlling and Administrative staff			91,281
Trigonometrical Branch Office			1,59,529
	GRAND TOTAL		5,40,809

There was therefore an increased expenditure of ₹95,917 on scientific work, which was entirely due to the increased cost of No. 24 Party, which had temporarily to be very considerably enlarged, to provide triangulation in advance for the topographical expansion.

19. At the request of the Government of Eastern Bengal and Assam, a surveyor was deputed to accompany an expedition which was sent to define the boundaries of the Lushai Hills, Chin Hills, and Arakan Hill Tracts, and an area of 1,194 square miles was surveyed on the $\frac{1}{4}$-inch scale.

TOPOGRAPHICAL SURVEYS.

20. *Central and United Provinces and Central India States.*—No. 1 Party continued to carry out supplementary survey, mainly on the 2-inch scale, of the area previously surveyed cadastrally in the Central and United Provinces. An area of 2,619 square miles was thus revised and contoured, while in addition, in the adjoining Native States of Central India, an area of 528 square miles was re-surveyed. An area of 2,274 square miles was also triangulated in advance, while 203 miles of traversing for topographical requirements was also completed, in addition to a boundary traverse of 86 villages, aggregating 433 miles, undertaken for the Local Government.

21. *Berar.*—No. 2 Party, which, as in previous years, was an instructional one for the training of young officers of the Provincial service, continued the topographical survey of Berar and an area of 1,316 square miles was mapped on the 1-inch and 2-inch scales, while a tract of 2,180 square miles was triangulated in advance. The boundaries of all A and B class forest reserves falling within the area under survey, aggregating 286 miles, were surveyed on the 4-inch scale for the Forest department.

22. *Bombay Presidency.*—No. 17 Party re-surveyed on the 2-inch scale 1,250 square miles of old survey, and revised and contoured 1,108 square miles of the east and west Khándesh districts and of the adjoining States of the Central India Agency. Besides this, an area of 3,375 square miles was triangulated in advance, while 423 linear miles of forest boundaries, falling within the area mapped, were surveyed for the Forest department on the 4-inch scale.

23. *Eastern Bengal and Assam.*—No. 20 Party commenced the topographical survey of this province and surveyed an area of 3,135 square miles on the 2-inch scale in the Sylhet, Tippera, and Mymensingh districts.

24. *Burma.*—Nos. 3, 10, and 11 Parties continued their surveys on the 1-inch 1½-inch, and 2-inch scales chiefly in the Pakôkku and Katha districts and in the Shan States. A total area of 7,856 square miles was surveyed, 4,785 being on the 1-inch, 2,303 on the 1½-inch, and 768 square miles of reserved forests on the 2-inch and 4-inch scales. More than half of the area surveyed on the 1-inch scale was supplementary survey.

25. *Madras Presidency.*—No. 19 Party continued topographical and forest surveys in the Madras Presidency. The forest surveys were on the 4-inch scale in Ganjám and completed the programme of 4-inch forest surveys in the Presidency. In future, forests occurring in the general programme of a party will be surveyed on the 2-inch scale as in other parts of India. The topographical survey consisted of 2-inch and 1-inch surveys in the Malabar and Nilgiri districts and in Coorg and of revision survey in Mysore State; the total outturn of the party was 39 square miles on the 4-inch, 1,512 on the 2-inch, and 605 on the 1-inch scale. An area of 289 square miles on the 2-inch scale was also surveyed by the Training Party in the Salem district.

26. *Northern Circle.*—No. 9 Party triangulated 1,534 square miles and surveyed 1,543 square miles in the Dehra Gházi Khan district on the 1-inch scale, and 770 square miles on the 2-inch scale. No. 12 Party triangulated 1,200 square miles and surveyed 1,582 square miles on the 2-inch scale in the Hazára and Attock districts.

No. 14 Party triangulated 1,365 square miles and surveyed 2,103 square miles on the 2-inch scale in the Kohát and Attock districts.

No. 18 Party triangulated 1,712 square miles and surveyed 1,267 square miles on the 2-inch scale, and 539 on the 1-inch scale, in the Dera Ismail Khan district. They also traversed 1,851 linear miles for the above topography and worked 400 bases in the Bári Doáb.

The Training party in the Jhelum district triangulated 790 square miles and surveyed 487 square miles on the 2-inch scale.

The area triangulated is smaller this year than last year, as a larger area was not required. The cost-rate is reduced from R9-10-0 per square mile to R8-5-0, mainly due to the triangulation this year being mostly for 1-inch instead of 2-inch survey.

The area surveyed under the Superintendent, Northern Circle, on the 2-inch scale has increased from 7,261 square miles last year to 8,911 square miles this year, in spite of the fact that a large number of surveyors were employed on 1-inch work. The cost-rate is reduced from R44-10-0 to R33-0-0 per square mile.

The area surveyed on the 1-inch scale was 5,360 square miles as against *nil* last year and the cost-rate was R24-5-0 per square mile. This cost-rate will be materially reduced next year. The increased area surveyed renders it difficult to keep the fair mapping up to date, and this difficulty will increase year by year until all the surveyors now under training are also trained to be fair draftsmen.

The Castle Hill estate in Mussooree was purchased during the year, and next recess all the parties will recess in close proximity to each other, a convenience that should result in better drawing and supervision.

27. *Bengal.*—The survey of the block of hills in the south of Monghyr mentioned in paragraph 35 of last year's report was completed. The total area was 183 square miles, on the 2-inch scale. The completion of the survey of the lower Sundarbans on the 2-inch scale was effected, 1,257 being traversed and surveyed in detail.

28. The outturn of the topographical surveys on all scales is as follows :—

	Square miles.
Central and United Provinces and Central India States	3,147
Berar	1,316
Bombay	2,358
Bengal	1,440
Assam	3,135
Burma	7,856
Madras	2,445
Northern Circle	14,271
TOTAL	35,968

FOREST SURVEYS.

29. The forest survey operations of the year were conducted principally on the scale of 2 inches = 1 mile, instead of, as heretofore, on the 4-inch scale. The work was carried out by the various topographical parties in whose sphere of operations the forests lay.

30. *Central Provinces.*—No. 2 Party surveyed an area of about 57 square miles of forests on 2-inch scale, and the boundaries of this area, approximating to 286 miles were traversed. This area includes certain reserves of A and B class forests of the Basim and Mángrúl *taluks* of the Akola division, and certain others of the Pusad and Dárwha *taluks* of the Yeotmal division.

31. *Northern Circle.*—No. 14 Party surveyed on the 2-inch scale the Khwarra protected forests in the Peshâwar district, and the Zira reserve in the Kohât district. It also surveyed on the same scale the Kalu Chitta reserve forests in Punjab, and the following unclassed forests under the Forest department, *viz.*, Makhad, Jabi, Tawin, Nakka Kalan, Goki, Tora Bhera, Saulian, Chitti, Trap, Gu-lial, Kot Chajji, Jalwal A and B, and Niari, as well as, those under the Deputy Commissioner of Attock, *viz.*, Maira, Nalhan, Amanpur, Bani Raman Shah, Narian, Sukhwan, Bhajur, Uchhri and Kalri.

The Gadbar reserve and part of the Girgi reserve in Baluchistán amounting to about 34 and 9 square miles respectively were also surveyed.

32. *Burma.*—No. 10 Party continued the survey of the reserves situated on the western border of the Mu division, and an area of 232 square miles was completed on the 2-inch scale. These reserves comprise the Wabo, Nabe, Tinwa, Nanbyan, Nangyittha, Myaingwun, and Kalawpa reserves. This party proposes to complete next, the survey of the Yabin, Pyaungwè, Myaingwun, Sareikta, Nangyittha, Nanbyan, Tinwa, and Nabe reserves, and will also survey 60 square miles of the Panlaung, Mainghein, Simaw, Nanhan, Munsin, and the

Mohlaing reserves of the Bhamo division ; it will also take up the Mosit reserve, of which the Government of India has sanctioned the survey, in advance of the regular programme of the Survey of India at the cost of the Forest department. No. 3 Party will survey the Thingadôn reserve of 47 square miles, in the Lower Chindwin district, in the course of its regular programme.

No. 3 Party made no special surveys for the Forest department, but in the course of its ordinary operations surveyed 275 square miles of reserved forest on the 2-inch scale in the Pakôkku district, Yaw Forest division. Similarly No. 10 Party surveyed 219 square miles of reserved forests in the Ruby Mines district, and also 4·5 square miles on the 4-inch scale in the Pinkan reserve. No surveys of forests in this circle are included in the programme of the Survey of India for 1908-09.

33. *Bombay Presidency.*—An area of 555 square miles, falling within the *taluks* of the west Khándesh district, together with an additional area of 1·25 square miles in the east Khándesh district was surveyed on the 2-inch scale. In the Shirpur, Sháháda, and Taloda (including Akhráni ranges of the west Khándesh district) 423 linear miles of forest boundary survey were traversed on the 4-inch scale.

34. *Madras Presidency.*—No. 19 Party finished the 4-inch forest survey of the Ganjám district, with an area of 39 square miles, thereby completing all the work required to be done by the Forest department on that scale. In South Canara, the same party traversed 23 linear miles of forest boundaries ; some 40 linear miles of undemarcated boundary still remain to be traversed. In South Malabar, the external boundaries of the following reserves were traversed, *viz.*, part of the new Amarambalam, Silent Valley, Attapadi Valley, blocks 1, 2, 3, 4, and part of 5. The following reserves were surveyed on the 2-inch scale, *viz.*, Erambadam, Kariam (partly), Muriat (partly), Kanakuth, Pokote, Panangode, Chattamburai, Nilambar, Arimbrakuth, Valuvas Teri, Kurrampoya, Panakadan, and Beypore Tope, with an aggregate area of 26 square miles. In North Malabar the following reserves were surveyed on the 2-inch scale :—Edavankam, Kotiyur, Kamban malai, and Huntley. In North Coimbatore one newly demarcated forest boundary (Attikan Estate) was surveyed by a surveyor lent to the Forest department. In Coorg nearly the whole of the province was triangulated in advance of the 2-inch detail survey. In the Nilgiris, 2 square miles of the Murkurti Peak reserve was surveyed on the 2-inch scale.

CADASTRAL AND TRAVERSE SURVEYS.

35. No purely cadastral work was done in Bengal and Eastern Bengal, since this work is now done by the Settlement officers of these provinces. The cadastral establishment of No. 4 Party was handed over to the Settlement department on the last day of the survey year 1906-07.

36. Three parties were employed in the traversing of areas in Bengal and Eastern Bengal.

37. In Burma 970 square miles were cadastrally surveyed by No. 7 Party in the Thayetmyo, Pegu, Pyapôn, and Yamèthin districts, and 328 square miles were also traversed in Pegu and Yamèthin. The work assigned to this party having come to an end, it will be disbanded at the end of 1908, and all future revenue surveys will be carried out by the local Land Records department.

38. The total area traversed and surveyed cadastrally during the year is as follows :—

Provinces.	Traversing, sq. miles.	Cadastral survey, sq. miles.
Bengal	3,609	...
Eastern Bengal	2,694	...
Burma	328	970

CANTONMENT SURVEYS.

39. The survey of cantonments was continued by two small parties. The cantonments dealt with, 26 in number, belong to the Peshâwar, Râwalpindi, Meerut, Lucknow, Poona, and Mhow Divisions and to the Bannu Brigade, and all were either entirely or practically completed. The surveys of cantonments were as formerly carried out on the 16-inch scale, the bázárs being surveyed on the scale of 64 inches = one mile, and the areas in acres surveyed were 36,497 and 571, respectively.

In addition a considerable amount of advance traversing was carried out in the bázárs of Secunderabad and Bolarum, which are to be surveyed next season.

RESULTS.

40. The total outturn of detail topographical and forest surveys on all scales is 35,968 square miles, against 25,740 of the previous year. No surveys on a scale smaller than 1 inch = 1 mile were carried out during the year except the area of 1,194 square miles mentioned under special operations, in the Lushai Hills. The total area triangulated and traversed for topographical or forest surveys is 37,396 and 1,489 square miles respectively, against 33,535 square miles for the previous year. The total area of cadastral surveys is 970 square miles and of the area traversed for this purpose is 6,631 square miles against 2,370 and 8,193 respectively for the previous year.

	Sq. miles.
4-inch scale	43
2 „ „	21,928
1½ „ „	2,303
1 „ „	11,694
TOTAL	35,968

HEAD-QUARTERS OFFICES, CALCUTTA.

41. The general superintendence of these offices continued under Colonel F. B. Longe, R.E., Surveyor General, up to February 1908, when he left India on leave, and Colonel S. G. Burrard, R.E., F.R.S., took over his duties. In January, the whole of the Map Reproducing and Issuing Offices were combined into one Map administrative charge, and placed under Major W. C. Hedley, R.E., as Superintendent, Publication, with the Assistant Surveyor General in charge Drawing Office and Assistant Surveyor General in charge Photo-Litho Office as his assistants. On the 1st of April Major Hedley returned to the executive charge of the Photo-Litho. Office and Colonel J. M. Fleming, I.A., who up to this, had held charge of the Surveyor General's and the Mathematical Instrument Offices, became Superintendent of Map Publication until he took leave on July 2nd, when Map Publication was placed under Major W. M. Coldstream, R.E. Major J. M. Burn, R.E., held charge of the Surveyor General's and Mathematical Instrument Offices from the 1st April to the close of the survey year.

42. *Map Publication Office.*—The re-organisation of the various Map Publication Offices was continued under Major Hedley, R.E., the officer lent by the Ordnance Survey for this purpose. He left India on the 26th of August, and his report on his work has been submitted to Government. In addition to many technical improvements introduced during his tenure of office the department is indebted to Major Hedley for new schemes of payment and to the grading of the establishments in the Photo-Litho. Office and Drawing Office.

These schemes strengthen the Surveyor General's control and enable him to reward good work, and will, it is believed, tend greatly to efficiency. At Major Hedley's suggestion a special grant has been sanctioned for the payment of overtime work. The need for payment of overtime work has been felt for some time, and without such payment it seems doubtful whether the department could have continued to meet extra-departmental demands and also to deal efficiently with the new standard sheets which are printed in colours.

43. The main work of the publication offices is the reproduction of our standard sheets. The number of new sheets received during the year under report, *i.e.*, up to September 30th, has been 230. Of these 103 have been printed, 22 are ready to print, 64 have been proved and are awaiting the return of the proofs from the circle offices, and in many cases from the Government of India and Local Governments, and 41 are in the various stages of reproduction preparatory

to proving. Although only about two-thirds of these maps are in colours this result may be considered satisfactory, especially when it is taken into consideration that of the 103 printed nearly all have been printed in the last seven months. The number of standard sheets we may expect in the year beginning 1st October 1908, may be taken as about 150, and there is every reason to believe that the reproducing offices will be able to deal in 1908-09 both with the majority of these and with those remaining from 1907-08. The heavy increase in work involved by the new system of publishing the sheets in the smaller size and in colours will be realised, when it is considered that under the old system the outturn of the year would have been published in about 75 sheets, which would each pass at most twice through the machine, instead as now of about 150 sheets, each of which must pass through the machine 5 and in many cases 6 times, *i.e.*, instead of 150 printings we must now undertake 750 or more printings The quality of the standard sheets is improving as regards the drawing of the originals and their reproduction, and there is no reason why they should not eventually compare favourably with any maps of their class produced in other countries, but there is still room for improvement.

44. Of other important departmental maps, up to the present date, 23 sheets of the Map of India and adjacent countries on the $\frac{1}{\text{million}}$ scale have been published, 5 are at press in different stages, and 16 are in hand in the various drawing offices. At the present rate we may hope to have these maps published for the whole of India some time in 1910. It was at first intended to engrave the $\frac{1}{\text{million}}$ sheets at once, but the importance of bringing out an edition for the whole country at an early date, and the fact that for the greater part of India, the material available is from old surveys much out of date, have led to the decision to engrave only such sheets as could be compiled from modern surveys, and to push on the preparation of a preliminary edition of the whole map by photography.

As a preliminary edition (to be replaced when new material becomes available), is being compiled to meet a pressing want, and is being published by the most economical process, the standard aimed at cannot be the highest, but it is hoped it may meet immediate requirements.

45. Intimately connected with the decision to produce the $\frac{1}{\text{million}}$ maps by photography, has been the decision to engrave the new degree sheets. So far, no degree sheets, based entirely on new surveys, have been submitted for publication, and the number of degree sheets that can be expected each year is not large. Each degree sheet includes 16 1-inch sheets, and they will be prepared after the publication of the component 1-inch sheets. Degree sheets compiled from the old surveys, would be little better than the atlas sheets on the same scale, which must remain our standard $\frac{1}{4}$-inch maps until they are gradually replaced. The style of the engraved degree sheets is not yet finally decided, and it is possible that the first few sheets engraved may be of a more or less experimental character.

46. The general maps of India, which the department maintains, were limited by the Survey Committee of 1904-05 to the following:—

1.	India on the scale of	32	miles	=	1 inch	
2.	"	"	64	"	"	
3.	"	"	80	"	"	(as a railway map).
4.	"	"	96	"	"	
5.	"	"	192	"	"	
6.	"	"	256	"	"	

In addition to these, the 128-mile map is still maintained for departmental purposes. As mentioned in the last departmental report, a new engraved map on the 32-mile scale was commenced last year and work on this has made fair progress; about two thirds of the map has been compiled "*de novo*" and the remainder will be compiled during 1908-09. About one-third only has been cut on the copper. It is early yet to estimate the date of publication, as by the time the whole map is engraved many changes must be expected, and the process of final examination in so large a map is apt to be lengthy, but it is hoped that the map may appear during 1911. It is badly wanted, not only as a complete map in itself, but as the basis from which general maps of provinces, divisions, and other areas, can be rapidly and easily obtained. In the meantime, the old

map on the same scale has been brought up to date on stone and two editions have been published, one in skeleton outline and one in outline with hills in brown, and another edition in the authorised colours will be ready during 1908-09.

The old 64-mile map has been brought up to date on copper and a new edition published.

The plates of the 80-mile map, specially required for illustrating reports, are being corrected and a new railway map on this scale has been published for the Railway Board during the year.

The plates of the 96-mile map are being corrected; those of the 192-mile map have not yet been put in hand. The 256-mile map has been brought up to date and an edition will shortly be published.

It will be seen that the general maps are still far from completion, but satisfactory progress is being made.

47. Of late years, many of the old standard sheets have fallen out of print and although these sheets will all eventually be replaced by the new surveys, it is necessary to maintain our stocks in the meantime. During the year, the deficiencies in stock as regards Bombay have been made good, and a large number of old sheets of other provinces, for which there were urgent demands have been reprinted. The Drawing office and Photo-Litho. office between them turn out from 20 to 30 reprints *per mensem*.

48. A very large number of maps, plans, and diagrams, have been reproduced for other departments in the Photo-Litho. office. When the originals submitted have been at all suitable, all such work has been accepted. The number of unsuitably drawn maps submitted for reproduction continues to decrease. The Photo-Litho. office could deal with a still larger number of small extra-departmental maps than it now receives.

49. The Superintendent, Map Publication, is frequently asked to prepare special maps which involve re-drawing, and it has been found necessary to refuse a large percentage of such applications; the number accepted is, however, not much less than in former years. Among many such maps which have been prepared or corrected in the Drawing office during the year are Postal maps of Provinces, Gazetteer maps, Educational maps, special maps of Native States, Railway maps, and the Railway and Canal map.

50. *Drawing Office.*—The statement below shows generally the outturn of the office during the year The office has benefited by the formation of a special compilation section under an experienced Provincial officer, which deals with the more important work, namely, the compilation of the new 32-mile map of India and of the preliminary edition of the $\frac{1}{\text{million}}$ maps.

Statement.

Class of map.	Scale.	Number of sheets in hand during 1907-08.	Number published.
General maps of India . .	1″=32 miles to 1″=256 „	56	16
India and adjacent countries .	$\frac{1}{\text{million}}$	34	7
Provincial maps . . .	Various	21	13
District maps . . .	¼″, ½″, and 1″ =1 mile.	24	12
Standard sheets . . .	Various	565	379

Class of map.	Scale.	Number of sheets in hand during 1907-08.	Number published.
Atlas sheets	$\frac{1}{4}$"=1 mile	10	10
Administration Report maps .	Various	7	7
Plans of Cities and Cantonments.	Various	1	...
Triangulation and Traverse charts.	Various	136	93
Index maps	Various	26	15
Miscellaneous maps . .	Various	50	21
Maps for other departments .	Various	196	59

51. *Engraving Office.*—The chief work of the office has consisted in the engraving of the new 32-mile map, the completion of those $\frac{1}{\text{million}}$ maps on which some progress had been made and in which the material used was considered sufficiently good, the completion of the plates of 16-mile maps of Madras and Bengal, the correction of the plates of certain general maps, and the supply of transfers from copper plates to the Photo-Litho. office for the preparation of extra-departmental maps.

The outturn of the copper plate printing section is—59,153 prints.

52. *Photo-Litho. Office.*—The outturn of the last three years is shown in the statement below:—

Year.	Number of pulls of Maps and Plans.
1905-06	1,284,968
1906-07	1,123,001
1907-08	1,563,453

The number of maps printed during the year is as follows:—

Departmental Maps	891
Extra-Departmental Maps	1,175
Cadastral Plans	792
TOTAL .	2,858

The arrears, if such a term can be applied to the cushion of work which it is necessary to keep in hand, in order that the various sections may work smoothly and methodically, are now small, and every effort is being made to reduce them to the minimum that will allow of efficient and economical working. The improvement during the year has been most marked in the negative touching section, one in which the work is difficult and requires highly skilled workmen, and which Major Hedley in his report last year termed the weak spot of the office. As mentioned above, though the office has not succeeded in publishing the whole number of new standards received up to date, it is believed that it is now in a position to deal with the yearly outturn of the field parties, and the quality of the work is steadily improving. The new scheme of grading and

paying the establishment was introduced in June and it is too early yet to report on the result.

53. During the year, new plant has been received for the preparation of half-tone blocks, and the office now deals rapidly and efficiently with work of this class. The increase in the demand for half-tone illustrations on the part of officials has been marked since the new plant has been brought into use.

54. The cost of the office during the year has been R1,88,966, including R21,612 supervision charges, R1,45,817 establishment charges, and R21,537 contingent charges, but excluding the cost of stores and plant obtained from England. The corresponding expenditure last year was R1,77,529. A sum of R49,828 has been recovered in cash or book debit payments for minor extra-departmental work, and the value of uncharged-for work done for the Government of India and for the department at office rates was R1,30,178.

55. *Map Record and Issue Office.*—The face value of the maps received for stock during the year amounts to R3,38,360; of this, R37,127 is the face value of maps printed at Dehra and in the Engraving office, the remainder is the face value of departmental maps printed in the Photo-Litho. office.

56. The number of original maps, volumes of computations, etc., received into store from other departments or branches of the office, was 7,708, and 4,925 were issued.

57. The number of maps issued during the year was 130,960, having an aggregate value of R1,28,910. Of this sum, the net total charges for maps supplied to Government officials on book debit amounted to R54,183, those to the India Office to R7,923, and to the agents, R4,773. The sum of R19,576 was realised in cash from sales to private individuals, and the value of the maps issued for departmental use was R42,455.

58. The transfer of the forest maps was steadily proceeded with during the year. The whole of the Madras forest sheets together with 49 sheets of the Punjab, making a total number of 41,942 copies, were despatched to the Officer in charge, Forest Map office, Dehra Dún, for storage.

59. The work of overhauling and re-registering the original maps and volumes has also been in hand. All the current fair sheets and plane-table sections have been re-registered and there now remains only the work of examining the coloured originals, corrected prints, etc., and of cataloguing and marking the triangulation angle books and field records. It is hoped to finish this work during next year.

60. The revision of the map catalogues was also taken in hand and a new general catalogue to replace the various catalogues previously in use, is in course of publication.

61. The new method of numbering the sheets of standard maps has necessitated the re-arrangement of storage accommodation for the printed maps. This work will eventually involve arrangements for some 7,000 maps, most of which will be published in editions of 500 copies and must proceed gradually, as the old maps are superseded by the maps of the new surveys.

62. *Mathematical Instrument Office.*—During the year under report, *i.e.*, from 1st April 1907 to 31st March 1908, there has been a decrease in the demands made on this office. For each of the last three years, *i.e.*, 1905-06, 1906-07, 1907-08, the value of instruments, etc., issued to public offices was R4,22,179, R3,82,345 and R3,66,334, the value of repairs to instruments received for repairs and returned in a serviceable condition was R41,818, R42,181, and R42,542, and the value of instruments received from Government officers when "no longer required" was R76,096, R58,128, and R70,486.

The book value of the stock of instruments, etc., in the serviceable store at the end of each of the last three years was R4,53,251, R5,35,535, and R7,62,415. The larger stock in hand at end of the year under report compared with the previous year is partly due to the falling off of issues and partly to the fact that most of the instruments in store are new, the old ones having been repaired and re-issued, and partly to the fact of the stock having run dangerously low in recent years.

The book value of the stock of instruments, etc., in the repairable store at the end of each of the last three years was R1,19,907, R1,12,389, and R98,578. As usual, no instruments for which there was demand were kept in the

repairable store for any length of time; they were sent to the workshop for repairs and transferred to the serviceable store for issue, as soon as possible.

Two "Profit and Loss" statements have been prepared for the year under report—one showing the results of the operations of the stores branch and the other of the workshop. The stores statement shows a nominal loss of R9,982 and the workshop statement a loss of R5,586. The value of the serviceable stock on hand on 31st March 1908 having been very large, the amount taken in the stores statement on account of $3\frac{1}{2}$ per cent. on this value was correspondingly large, and this accounts for the loss. The loss in the workshop statement is only apparent; it is more than covered by the amount (R9,206) paid during the year on account of grain compensation allowance to the men of the establishment.

The number of men and boys employed in the workshop at the end of each of the last three years was 421, 451, and 477.

The value of work done in the workshop during each of the last three years was R2,01,083, R2,16,730, and R2,54,916.

The value of the instruments, etc., manufactured in the workshop for the serviceable store during each of the last three years was R82,638, R87,588, and R1,11,901, and the value of instruments, etc., purchased locally for the serviceable store during each of the last three years was R17,810, R4,189, and R1,943.

The value of instruments, material, etc., obtained from England through the Director General of Stores, during each of the last three years was R2,87,740, R4,36,240, and R4,94,985.

During the year under report, the Secretary of State for India sanctioned the scheme appointing a Manager and two Assistant Managers to carry on the superintendence of the stores and workshops. The Manager was permitted to take privilege leave for 3 months combined with 2 months' deputation, in order that he might visit the principal manufacturers in England, from whom this office obtains its supplies, to enable him to study the latest developments. During Mr. Ferrier's absence, Mr. Woodhouse acted as Manager. Mr. Connell joined the office during the year as junior Assistant Manager.

The stock-taking of the serviceable and repairable stores was completed and statements made out showing excesses, shortages, and discrepancies. In future stock-taking will be carried out annually.

Great benefit was derived in one of the large rooms of the workshop from the introduction of large propeller fans for ventilation. In the worst weather the atmosphere was kept sweet and clean, enabling the men to work with far more energy than in previous years.

Great progress has been made in the quality of work turned out. During the year, the manufacture of a few reversible levels was started, but the work had to be put on one side when the usual rush of repair work came in. Several 5″ Everest theodolites were also put in hand, one of which was finished; it is no doubt a success and proves that great progress has been made in the workshop during recent years.

A large number of self-centring theodolite stands were manufactured during the present year, and have been attached to old theodolites which were sent in from parties for that purpose.

The electric installation, which was completed during the previous year, has proved efficient.

A price list with reference numbers was published on the 1st April 1907. Another more complete one will be issued during the year 1909.

BRANCH OFFICES.

TRIGONOMETRICAL OFFICE.

63. Mr. J. Eccles, M.A., officiated as Superintendent, Trigonometrical Surveys, up to 11th November 1907, on which date he was relieved by Colonel S. G. Burrard, R.E., F.R.S.; Mr. Eccles again assumed superintendence from 27th February 1908 to 26th September in addition to his charge of the technical offices, while Colonel Burrard officiated as Surveyor General.

Mr. T. A. Pope in charge of the Forest Map office continued the superintendence of the Photographic office throughout the year.

Lieutenant C. M. Thompson, I.A., C. G. Lewis, R.E., J. H. Field, R.E., and A. H. Gwyn, I.A., who were appointed to the Survey of India as Assistant Superintendents during the year, were instructed in topographical and trigonometrical work. Of the five Sub-Assistant Superintendents appointed, one resigned and the others were put through a course of training during the year.

64. *Computing Section.*—The following computations were carried out in the Computing office for incorporation in the Synoptical Volume of the North-East Longitudinal series:—

(*a*) Computations of latitudes, longitudes and azimuths of—
  (1) Ayartoli tea-plantation triangulation.
  (2) Mr. Barckley's and Colonel Tanner's points.

(*b*) Computations of the heights of—
  (1) Mussooree, Simla, Garhwál, and Siwálik triangulation.
  (2) Gandak river Survey.
  (3) Someshwar triangulation.
  (4) Ragshi-Gwanagarh triangulation.

(*c*) The azimuth list of the principal and secondary stations has been completed and that of the intersected points is nearing completion. The descriptions of the stations in the co-ordinate list have been compared against the angle books.

Rai Sahib Ram Singh's triangulation in northern Tibet and Chinese Turkestan, 1906, and Rai Sahib Natha Singh's observations in Nepal for heights were reduced.

Mr. Morton's work in Lushai and Captain Gibbon's work in Persia are in hand.

Miscellaneous computations for Colonel Burrard were done, and co-ordinates of a few points were altered from their former to a new origin.

The work of compiling the levelling volume has been continued, and all the bench-marks of India are being re-numbered by degree sheets.

Compilations of data for trans-frontier degree charts are progressing. These include a new numbering of the Himalayan and Trans-Himalayan peaks, as the existing system of nomenclature for peaks has for a long time been considered faulty and confusing. Colonel Montgomerie's system of giving a letter to each snowy range with serial numbers for peaks in that range is intelligible and scientific, but it has been found difficult in practice to say where one range ends, and another begins. So that even this system has not been free from confusion. But much greater confusion has been caused by the later procedure of giving the initial of an observer's name to the peaks he observes, *e.g.*, we may have in close proximity R23 representing the 23rd peak in Ryder's Tibetan triangulation and R101 representing the 101st peak in Robert's Darjeeling triangulation; advantage has therefore been taken of the numbering of the degree sheets to introduce a systematic numbering of the peaks.

Each degree sheet will have a corresponding chart; thus to "sheet 70 J" will correspond "chart 70 J". In each chart the peaks will be numbered serially thus $\frac{\text{Pk. 1}}{70\text{ J}}$, $\frac{\text{Pk. 2}}{70\text{ J}}$, etc., and this enumeration is not to be modified when fresh peaks are observed. When a second edition of a chart is brought out with new peaks upon it, the numbering of the latter will be in continuation of the numbering in the first edition, that is, the original numbering of a peak will never be changed. When a peak has a well known name it will be put in brackets after the number, thus $\frac{\text{Pk. 39}}{53\text{ I}}$ (Leo Pargial.)

The sheet number at once roughly locates the position of the peak and in the corresponding chart will be found the latitude, longitude, and the height, if observed. It is hoped that this method will be free from the difficulties which beset the present system, and the co-operation of geographers and the public in general is invited.

The three first parts of the *Sketch of the Geography and Geology of the Himalaya Mountains and Tibet*, by Colonel Burrard, R.E., F.R.S., and Mr. H. H. Hayden, B.A., F.G.S., were printed and distributed. The publication of this book takes place at the close of the first century of geographical exploration in the Himalaya.

The printing of the Synoptical volume of the North-East Longitudinal series, and of Major Lenox-Conyngham's paper on *Pendulum Observations* and of the pamphlet on *Routes in the Western Himalayas, Kashmir, Punjab and Northern India* is fairly advanced.

During the year 40 officers were supplied with data from the records in this office.

The meteorological observations continued as usual.

The necessary professional aid in connection with the protection of stations was rendered to the office of the Superintendent, Trigonometrical Surveys.

Six hundred and forty-seven stations were repaired by the district officers at a cost of ₹4,570.

Out of 333 districts from which the reports are annually due, 6 failed to make returns.

The services of one computer were lent to the office of the Chief of the Staff at Simla for about 2 months.

65. *Drawing Section.*—In the Drawing office the following maps were either completely or partly drawn and sent to press:—

(1) One Sind Level sheet.
(2) Six Punjab Level sheets.
(3) One triangulation chart.
(4) Two maps for the Foreign Office.
(5) Eight diagrams and maps for Major Lenox-Conyngham's paper on Pendulum observations (Professional paper No. 10).
(6) Map of the Civil Station of Rāwalpindi showing the city, old and new cantonments.
(7) Map of the Civil Station of Murree.
(8) Plan of the Civil Station of Campbellpur.
(9) Nine miscellaneous maps.

The following maps are nearly ready:—

(1) One Punjab Level sheet.
(2) Revision of the map of the Dehra Dún Municipality and Cantonment.
(3) One 2-inch sheet No. 308 S. W. of the Punjab.

The following are still in hand:—

(1) Sheets Nos. 52, 61, 62, and 77 of the Map of India and adjacent countries.
(2) Forty-three triangulation charts of the North-East Longitudinal series.

The following are also in hand:—

(1) New Index Chart to the Great Trigonometrical Survey of India.
(2) Seven 'special' Charts connected with the triangulation charts of the North-East Longitudinal series.
(3) Map of Northern Tibet and Western China, scale 4 miles = 1 inch in 13 sheets. Outline finished, hills remaining.
(4) Sixty-four charts of the triangulation of the North-Western Himalaya series.
(5) Sheets No. 82 of the Map of India and adjacent countries.
(6) Sheet No. 70 (2nd edition), of the Map of India and adjacent countries.
(7) Five Punjab Level sheets. Headings, footnotes (including symbols) and area statements, were completed on 163 maps which were also sent to press.

The proofs of all maps have been examined and corrections carried out as usual, and careful scrutiny given to all the printed copies before issue.

Four thousand one hundred and twenty-six maps were coloured.

For the future, the work of the Drawing office will, as hitherto, be confined to the drawing of the maps of India and adjacent countries, the level sheets, triangulation charts of the North-Eastern Longitudinal series for the Synoptical volume, triangulation charts, special maps (such as Dr. Stein's, Ram Singh's and Lal Singh's maps of Turkestan and Western China), geological maps, maps for professional papers, maps for the Chief of the Staff, miscellaneous maps and to the colouring of about four thousand maps during the year.

66. *Photo-zinco Section.*—One thousand four hundred and sixty-seven maps and diagrams were photographed against 1,177 during 1906-07 and 258,510 pulls taken against 223,186 in the same period.

The new lithographic machine press has been in full work throughout the year and was of the greatest service to the office. The principal work printed in it consisted of the new cantonment maps, many of them in two colours, of which 109,423 copies were printed off. A considerable number of Forest maps were also printed in it, and the saving of time effected thereby has been of much importance to the Forest department. It has been found necessary to retain in use most of the hand presses, not only for proving purposes, but also to enable the office to furnish the parties of the Northern Circle with reproductions of their fair maps and plane-table sections. The work has kept the four presses fully occupied throughout the year. It is expected that the new 2-inch standard forest maps will be printed at Dehra, as the forest details are to be inserted on them in the Forest Map office there and they will be stored in that office. If this is arranged, the photo-zinco section will shortly have as much work as it can undertake, and the question of increasing its printing capacity may have to be considered.

Instruction in map reproducing processes was given, as in previous years, to all the newly joined Imperial and Provincial officers during their course of instruction in the Survey School. As these officers are sent at once to field parties on the conclusion of their course of instruction, they would probably have no opportunities of acquiring this most useful knowledge later on.

The services of Sergeant Lucas, R.E., of the Photo-Litho. office of the Ordnance Survey engaged to assist Major Hedley, R.E., in the work of reorganisation of the reproducing offices were placed at the disposal of this office from 28th April to 25th September.

67. Photographs of the sun were taken on 309 days.

Forest Map Office.

68. This office remained under the superintendence of Mr. T. A. Pope, Superintendent, 2nd grade, throughout the year.

During the year under report, 11,177 maps were issued to forest and other officials, and to the public. Last year, the number issued amounted to 11,100. Of the above number, 4,017 were coloured maps.

The principal mapping executed during the year comprised the usual 4-inch standard sheets of the Forest surveys, of which 78 were published and 25 were in the press at the close of the year, while 126 were in various stages of progress. These latter include 69 sheets of the second edition of the Kumaun-Garhwál series. Of the working-plan maps and other special maps prepared for the use of the Forest department, 22 were published, 9 were in the press, and 37 were being drawn at the close of the year. As there are no maps of the Madras Presidency showing the distribution of forests, a series of special district maps, on the 4-mile scale was commenced at the request of the Board of Revenue, Madras. Those of five districts were in hand at the close of the year, *viz.*, South Canara, Coimbatore, Tinnevelly, Madura, and Cuddapah.

The large stock of computation volumes, charts and other records, now stored in the office has been arranged and stored in new racks. They are now being indexed but this cannot be completed until the remaining records are received from the Calcutta office. All the field sections surveyed by the Forest Survey branch have been bound up, numbered, and stored in tin tubes. Indexes of these are also in course of preparation.

The number of maps received for storage from Calcutta office was 56,020. A large number have yet to come and the erection of new racks to receive

them has gone on steadily throughout the year. When the office was built, it was not known that this large stock of maps would eventually be kept in it and sufficient accommodation was not provided for them. It is now evident that further space will have to be arranged for, in the near future.

The amount realised by the sale of maps, and for work done for the Forest department, amounted to R2,018, as against R1,750 last year. Of this amount R1,110 was adjusted by book debit.

LOCAL DRAWING OFFICES.

69. *Mussooree Drawing Office.*—The Mussooree Drawing office was as last year, under the administrative charge of the Superintendent, Northern Circle.

Personnel.

Provincial Officers:

Messrs. R. R. Dickinson, in charge, and W. J. Cornelius (Retired Provincial Officers).

Subordinate Establishment:

3 permanent and 12 temporary Draftsmen and 1 Writer.

Four of the $\frac{1}{\text{million}}$ sheets of India and adjacent countries, *viz.*, Nos. 17, 18, 29, and 33 were submitted to the Superintendent, Northern Circle, and forwarded to Calcutta for publication. Sheets 24 and 30 will be forwarded shortly, while Nos. 35 and 38 are in hand. The drawing of thirteen degree sheets was in hand, and the compilation of thirty-two sheets was either completed or in hand. The histories of forty-degree sheets were also commenced this year and are in progress. Eleven sheets of Dr. Sven Hedin's routes in Persia on a scale of $1'' = 4$ miles were also submitted for publication. Sheets I and II of the map of Turkestan, on a scale of 1 inch =32 miles, were completed and sent for publication, and sheets III and IV are in hand. The total cost of the office for the year under report was R18,210.

70. *Burma Drawing Office.*—Mr. T. Shaw remained in charge throughout the season. He retired on superannuation pension on the 15th November 1907, but was re-employed for one year, which term has since been extended for another year. The office was employed in the same manner as in former seasons but the bulk of the work done was in connection with arrears of standard mapping of the various field parties which was very large. The fair drawing of both outline and hills of 16 sheets was done and of hills only 19 sheets, while the outline only of 6 sheets was fair drawn. Fifty-four standard maps received complete from the field parties were examined and 47 submitted for publication and blue prints of 28 outline sheets prepared by the Vandyke process, were supplied to the parties on drawing paper for the drawing of the hill sheets.

The outline of one degree sheet, 84 O was drawn and additions made to the hills of sheet 93 L. The total cost of the Burma Drawing office for the season was R14,814. The services of 10 draftsmen were lent to the field parties during the recess.

71. *United Provinces Drawing Office.*—This office was transferred in December 1907, from under the administrative control of the Deputy Surveyor General to that of the Superintendent, Northern Circle. Mr. J. M. Kennedy, Extra Assistant Superintendent, 2nd grade, remained in charge throughout the year, with Mr. F. W. Marten, Sub-Assistant Superintendent, 1st grade, as assistant. The subordinate establishment consisted of 13 draftsmen, 1 typer, and 2 computers.

Eighteen standard sheets or parts of sheets, *viz.*, 54 $\frac{I}{8}$, $\frac{I}{9, 13}$, $\frac{N}{1, 5}$, $\frac{N}{9, 13}$, $\frac{N}{3}$, $\frac{N}{4}$, $\frac{N}{7}$, $\frac{N}{8}$, $\frac{O}{1}$, $\frac{O}{5}$, 63 $\frac{E}{12, 16}$, $\frac{G}{1}$, $\frac{I}{2, 6}$, $\frac{I}{3, 7}$, $\frac{I}{4, 8}$, $\frac{I}{10, 14}$, $\frac{I}{12}$, $\frac{J}{12}$ were drawn and forwarded to Calcutta for publication. Six complete standard sheets are still in hand. Twenty-six traverse charts and two district maps (Bahraich and Gonda) were also submitted for publication. Eight traverse charts and two district maps are still in hand. The total cost of this office for the season was R19,010.

72. *Bengal Drawing Office (Imperial Sections.)* (*a*) *Standard Mapping.*—The following 20 standard maps on the 2 inches = 1 mile

scale, in 50 sections have been submitted for publication during the year:—72 $\frac{N}{3,4,7,8}$, $\frac{O}{1,2,3}$, 79 $\frac{C}{2,10,13,14}$, $\frac{G}{1,2,6}$, $\frac{I}{4}$ of two sections each and 79 $\frac{M}{1\&5,2\&6,3\&7,4\&8,12\&16}$ of four sections each. The drawing of sheets 72 $\frac{K}{11\&15}$, $\frac{N}{11}$, $\frac{O}{5,6,7}$ and 79 $\frac{J}{2,3}$ is well advanced.

(*b*) *Traverse charts.*—This section was increased during the year and placed under a separate supervisor. Thirty-six charts of Orissa and 43 of North Bihár have been sent for publication during the year and 22 charts of North Bihár are nearing completion. The charts of Chota Nagpur will be commenced early next year.

NEW STANDARD MAPS.

73. The following statement shows that the number of sheets surveyed is considerably more than the number fair drawn or published. This is mainly due to the field season being too prolonged and to the inexperience of the draftsmen employed on the fair mapping, but it is also due to the methods by which the new maps are prepared. In future it is hoped that there will be a great improvement in these respects. The methods are sound, but they take time to get into working order and the men have had little or no previous experience in them. The small number of maps published during the year is not due to any faulty reorganisation of the publication offices, but is due to these maps not yet having been submitted to the publication office or to their being sent in too late for publication before the end of the survey year, 30th September. It must be borne in mind that the recess season generally lasts till about the end of October and it is during this month or a little later that the sheets of any one year are submitted for publication. They consequently come into the following year's report.

At the same time it is thought that this return will be of interest on account of the information in a condensed form, which it gives to Local Governments.

Statement showing new 1-inch Standard Maps, surveyed, drawn, and published during 1907-08.

Locale.	NEW 1-INCH STANDARD SHEETS SURVEYED OR COMPILED.		NEW 1-INCH STANDARD SHEETS DRAWN.		NEW 1-INCH STANDARD SHEETS PUBLISHED.		REMARKS.
	Designation.	Total.	Designation.	Total.	Designation.	Total.	
Central and United Provinces, Berar, and Central India States.	54 L/7, 8, 12, 16 54 P/4, 7, 8, 12, 16	17	54 I/8	21	54 L/3, 4	24	
.....	55 H/4, 7, 8, 12, 16 55 I/5, 6 55 M/13	...	54 L/7, 8, 12, 16	...	55 H*/9, 10, 11, 14, 15	...	
.....	.....	..	54 N/3, 4, 7, 8 54 O/1, 5	...	55 I/1, 12 55 K/4, 8	...	
.....	.....	...	55 H/4, 7, 8, 12, 16	..	55 L/1, 5 63 G/11	...	
.....	.....	...	55 I/5, 6	...	63 K/9, 13, 14	...	
.....	.....	...	63 G/1 , 63 I/12	...	63 N/4, 8, 12	...	
.....	.....	...	63 J/12	...	63 O/1, 2, 5, 9	...	
Bombay Presidency	46 O/4, 8, 12, 16 46 K/1, 2, 5, 6, 10, 14	10	46 K/10 46 O/4, 8, 12, 16	5	46 K/3, 8	2	
Madras	49 M/11, 13, 15, 16 57 H/14 58 A/1, 2, 3, 4, 5	10	49 M/11, 15, 16 57 H/14	4	*Nil*	0	
Bengal	79 C/1, 2, 5, 6, 9, 10 79 G/1, 2, 5, 6, 9, 10, 13	17	72 N/3, 4, 7, 8 72 O/1, 2, 3	15	72 N/4 72 O/1, 2	3	
.....	79 F/4, 8, 12, 16	...	79 C/2, 10, 13, 14	...	.....	...	
.....	.....	...	79 G/1, 2, 6 79 J/4	...	.....	...	
Eastern Bengal and Assam	78 P/1, 2, 3, 4, 5, 6, 7, 8, 11, 14	10	78 P/1, 2, 3, 4, 5, 6, 7, 8, 11, 14	10	*Nil*	0	
Burma	84 K/3, 4, 7, 8, 10, 11, 12, 15, 16	17	84 K/3, 7, 8, 10, 11, 12, 15, 16	16	84 L/3, 4, 5, 6, 7, 8, 9, 13	27	
.....	84 M/2, 6, 10, 14 93 A/1, 5 93 E/4, 8	...	84 M/2, 6, 10, 14 93 A/1, 5	...	84 M/12 84 N/1, 8	...	

.....	.....	...	93 E 4, 8	...
.....	.....	...	.....	...
.....	.....	...	.....	...
.....	.....	...	.....	...
Shan States . . .	93 P 13, 13, 14, 15 102 C 4, 8, 12 . . .	12	93 P 11, 13, 14, 15 . . .	12
.....	102 D 1, 2, 3, 5, 9 . . .	...	102 C 4, 8, 12 . . .	...
.....	.....	...	102 D 1, 2, 3, 5, 9 . . .	...
Punjab . . .	38 L 8, 15, 16 38 N 8, 12, 16 . . .	38	38 K 12 38 L 8, 15, 16 . . .	23
.....	38 O 2, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16 . .	...	38 O 5, 9, 13 38 P 3, 4 . .	...
.....	38 P 3, 4 39 F 15, 16 39 I 13 . . .	...	39 E 15, 16 39 I 13 39 K 1 . .	...
.....	39 J 2, 3, 4, 6, 7, 8, 9, 10, 14 43 B 4 . .	...	39 J 2, 3, 4, 6, 7, 8, 9 10, 14 . .	...
.....	43 C 1, 2, 3 43 G 12 43 H 5 . . .	...	43 G 1 . . .	..
	TOTAL .	131		106

84 O 1, 4, 6, 8, 9, 10, 14 . . .	...	
93 B 8 93 C 2, 6 . . .	...	
94 A 1, 6, 10, 14, 16 . . .	...	
94 F 5 . . .	...	
93 G 3, 4, 7, 8, 11, 12 . . .	9	
.....		
93 P 1, 5, 9 . . .	...	
38 K 15 . . .	20	
38 L 10, 11, 12, 13, 14 . . .	...	
39 I 15 39 K 13, 14, 16 . . .	...	
39 N 3, 7, 11, 15 . . .	...	
39 O 1, 2, 6, 7, 15 44 C 6 . . .	...	
	85	

ESTABLISHMENT.

74. On completion of the period for which he was lent to the department by the Ordnance Survey of Great Britain, Major Hedley sailed for England on the 26th August 1908. During the time he was attached to the Survey of India, he displayed the greatest energy and interest in studying the map requirements of the country, in re-organising the map publication offices to suit these requirements and in adapting the *personnel* available in the department and capable of being recruited for it, to meet the changes which had been decided on in consequence of the recommendations of the Survey Committee of 1904-05. In this work he was loyally assisted by the Survey of India officers, who held charge of the various sections and also by the subordinates of the various offices. His proposals for the re-organisation of the offices as regards the pay and the duties of the staff were necessarily submitted towards the close of his stay in India, after he had acquired the necessary local knowledge, and though it has not been possible yet to give effect to all of them, it is hoped that with a few minor alterations they will soon be finally adopted.

That his work was eminently successful there can be no doubt, and the department owes a debt of gratitude to him for its thoroughness, and its business-like quality, and for the way in which he identified himself with the department generally, and sympathised with and allowed in his re-organisation for the difficulties under which work of this kind has to be carried out in India as compared with similar work in Europe. It is hoped that the benefits derived from his work will be permanent, and he carries with him the good wishes of the department on his return to England.

75. During the year under report the department has lost the services of two Imperial officers, *viz.*, by the retirement on account of ill health of Mr. B. G. Gilbert-Cooper and by the reversion to his regiment of Lieutenant R. S. M. Harrison, I.A.

The following officers have been appointed to the department :—

Mr. J. deG. Hunter as Mathematical Expert, Lieutenants J. A. Field, C. G. Lewis, A. A. Chase, R.E., and Lieutenants C. M. Thompson and A. H. Gwyn, I.A.

76. From the Provincial Service three officers have retired :—

Messrs T. Shaw, C. George, and G. A. Knight ; two resigned :—Babu R. D. Sharma and Diwan G. L. Chopra ; two died :—Messrs E. P. S. Hill and A. B. Smart, Junior. Six officers have been appointed to the Provincial Service as probationers.

EXPENDITURE.

77. The total cost of the department for the Survey year ending 30th September 1908 is R33,12,702 while that for the financial year ending 31st March 1908 is R33,42,728 against an estimated cost for 1908-09 of R35,59,650.

78. The actual expenditure on topographical surveys for the survey year 1907-08 amounts to R16,04,831 against R15,92,412 for the previous year. The expenditure on topographical surveys compares very favourably with that of last year when it is compared with the areas surveyed, which were 35,968 square miles in 1907-08 as against 25,740 square miles in 1906-07. This is in a great measure due to the reduction in the scale of surveys of the work executed by several of the parties but is also due to the improvement in capacity of the surveyors themselves, which is largely owing to the increased number of Imperial officers employed with the parties and to the supervision in the field and in recess of the Circle Superintendents.

79. The cost of the trigonometrical parties has risen, from R2,89,939 to R4,13,283, chiefly on account of the expansion of triangulation in Burma and Baluchistán ; this, however, is a temporary and not a recurring increase.

80. The cost of cantonment surveys for the year amounts to R52,906 against R68,018 last year, the decrease being due to the abolition of the third section on the completion of its work. The expenditure on the local drawing offices amounts to R53,412 against R68,905 for the previous year ; the decrease is mainly due to the employment of retired Provincial officers on reduced pay in place of full pay officers.

81. The expenditure on cadastral operations in Burma amounts to R1,57,847 against R1,74,290 for the previous year. The only party employed on this work will be disbanded and there will be no expenditure under this head in future.

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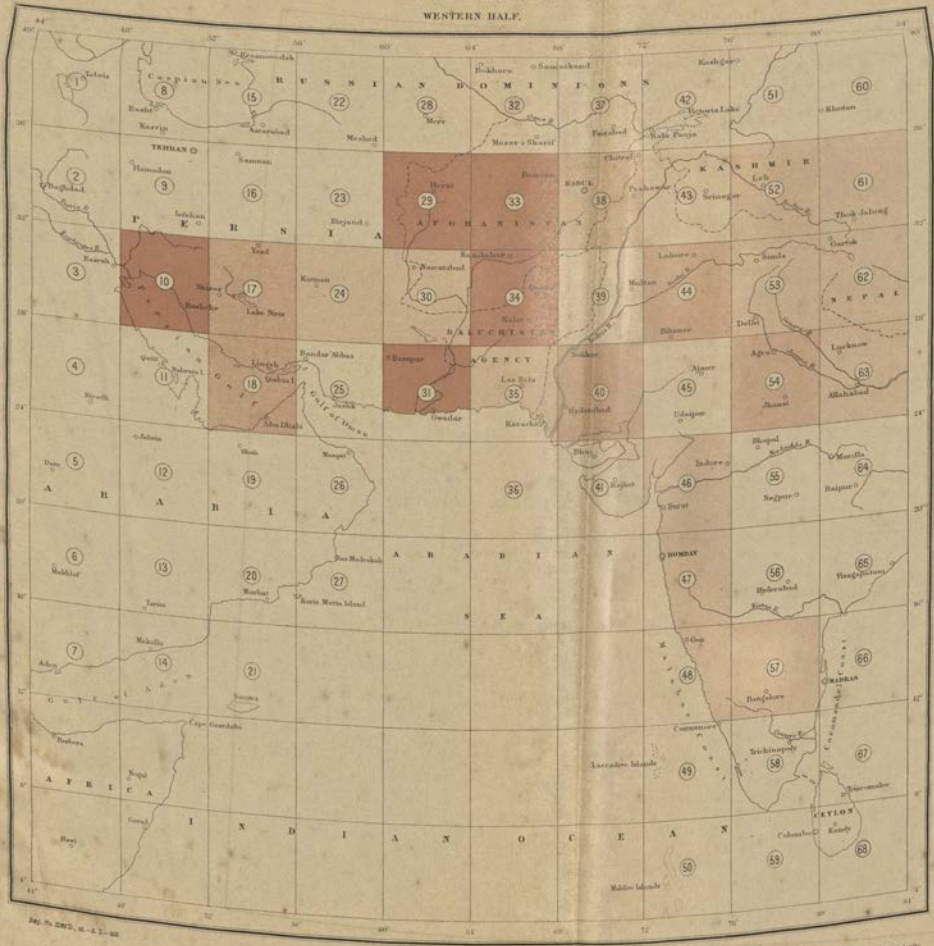
INDIA AND ADJACENT COUNTRIES SERIES.

On the Scale of 1:1,000,000.

WESTERN HALF.


RUSSIAN DOMINIONS
PERSIA
AFGHANISTAN
BALUCHISTAN
AGENCY
KASHMIR
NEPAL
ARABIA
ARABIAN SEA
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AFRICA
TEHRAN
KABUL
BOMBAY
MADRAS
CEYLON
Caspian Sea
Persian Gulf
Gulf of Oman
Gulf of Aden
Lake Nirie
Laccadive Islands
Maldive Islands
Socotra
Perim
Aden
Muscat
Karachi
Lahore
Simla
Delhi
Lucknow
Allahabad
Agra
Ajmer
Jodhpur
Indore
Hyderabad
Bangalore
Trichinopoly
Tuticorin
Colombo
Kandy
Goa
Surat
Nagpur
Baroda
Mhow
Mandalay
Rangoon
Bushire
Shiraz
Ispahan
Yezd
Kerman
Meshed
Herat
Kandahar
Quetta
Multan
Bhawulpur
Jeypore
Udaipur
Bhopal
Mirzapur
Seistan
Khiva
Bokhara
Samarcand
Kashgar
Yarkand
Khotan
Leh
Srinagar
Peshawur
Thok Jalung
Gartok
Kelat
Sonmiani
Gwadur
Las Bela
Hyderabad
Jacobabad
Sukkur
Bunder Abbas
Lingah
Bampur
Muscat
Maskat
Jask
Ras Mussendom
Ras Mohaikah
Ras Morbat
Kuria Muria Island
Socotra
Perim
Aden
Mocha
Jubain
Makalla
Shihr
Dhofar
Socotra
Cape Guardafui
Berbera
Obock
Zeyla
Harar
Ankober
Gondar
Massowah
Suakin
Kosseir
Cosseir
Thebes
Siout
Cairo
Alexandria
Port Said
Suez
Damietta
Rosetta
Jaffa
Gaza
Beersheba
Jerusalem
Damascus
Aleppo
Bagdad
Bussorah
Mosul
Diarbekir
Erzeroum
Trebizond
Tiflis
Baku
Astrakan
Orenburg
Khiva
Merv
Fyzabad
Kabul
Peshawur
Kelat
Sonmiani
Gwadur
Las Bela
Hyderabad
Karachi
Jacobabad
Sukkur
Multan
Lahore
Simla
Delhi
Agra
Lucknow
Allahabad
Ajmer
Jodhpur
Indore
Bhopal
Mirzapur
Jeypore
Udaipur
Surat
Nagpur
Baroda
Bombay
Hyderabad
Bangalore
Trichinopoly
Tuticorin
Colombo
Kandy
Goa
Mangalore
Calicut
Cannanore
Laccadive Islands
Maldive Islands
Mandalay
Rangoon
Bushire
Shiraz
Ispahan
Yezd
Kerman
Meshed
Herat
Kandahar
Quetta
Multan
Bhawulpur
Jeypore
Udaipur
Bhopal
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Seistan
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Yarkand
Khotan
Leh
Srinagar
Peshawur
Thok Jalung
Gartok

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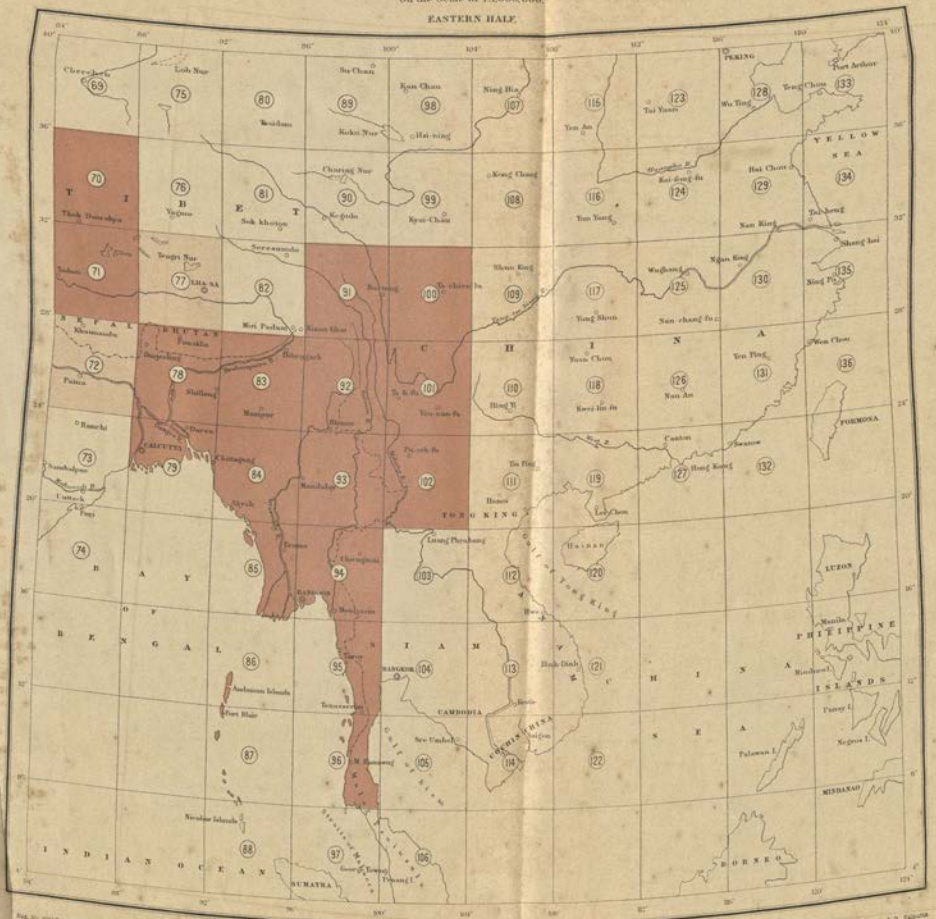
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Port Arthur
Wu Ting
Teng Chow
YELLOW SEA
Tai Yuen
Kai-feng-fu
Hai Chow
Yen An
Tun Yang
Nan King
Tai-kang
Shang hai
Yuan King
Wuchang
Sung Pan
Yang Show
Nan-chang-fu
Yen Ping
Yuen Chow
CHINA
Kwei-lin-fu
Nan An
FORMOSA
Canton
Swatow
Hong Kong
Hanoi
TONG KING
Lao Chow
Haidan
LUZON
Manila
PHILIPPINE ISLANDS
Mindoro
Panay I.
Negros I.
Palawan I.
MINDANAO
SEA
BORNEO
Hué
Tourane
Qui Nhon
Phan-rang
Phan-thiet
Baria
Saigon
Mytho
Vinh Long
Chau Doc
Ha Tien
Kampot
Kompong Som
Pursat
Battambang
Pak Nam
Chanthabun
Trat
Ko Chang
Ko Kut
Ko Samui
Ko Pha-ngan
Ko Tao
Ko Phuket
Ko Lanta
Ko Tarutao
Ko Adang
Ko Rawi
Ko Bulon
Ko Muk
Ko Libong
Ko Phi Phi
Ko Yao Noi
Ko Yao Yai
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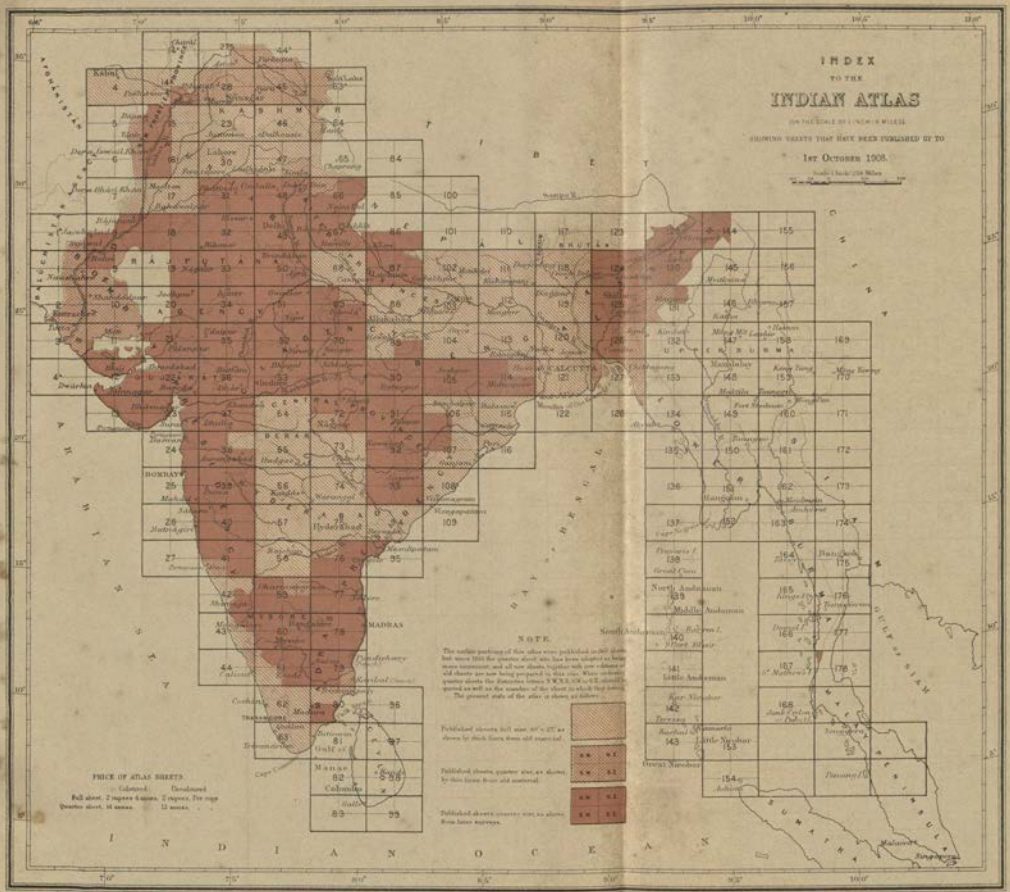
Ko Lidi
Ko Bubu
Ko Bulan
Ko Langkawi



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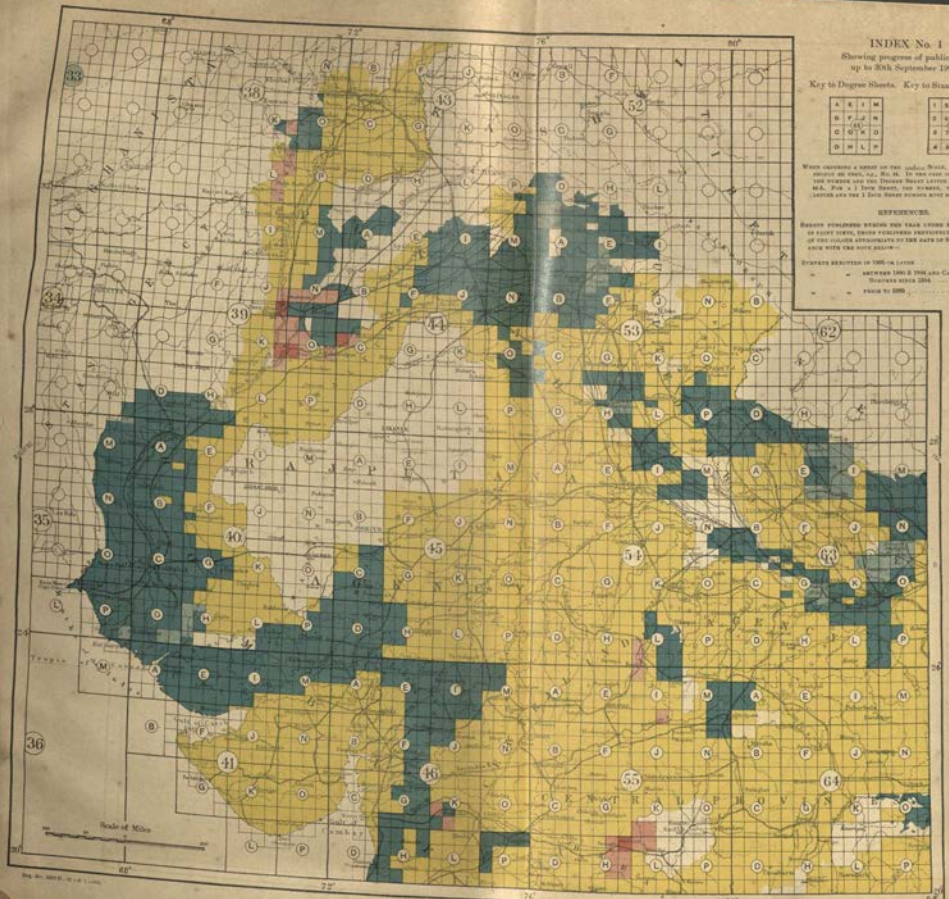
Published under the direction of Colonel F. B. LONGE, R.E., Surveyor-General of India.

1908

Litho. S. I. O., Calcutta.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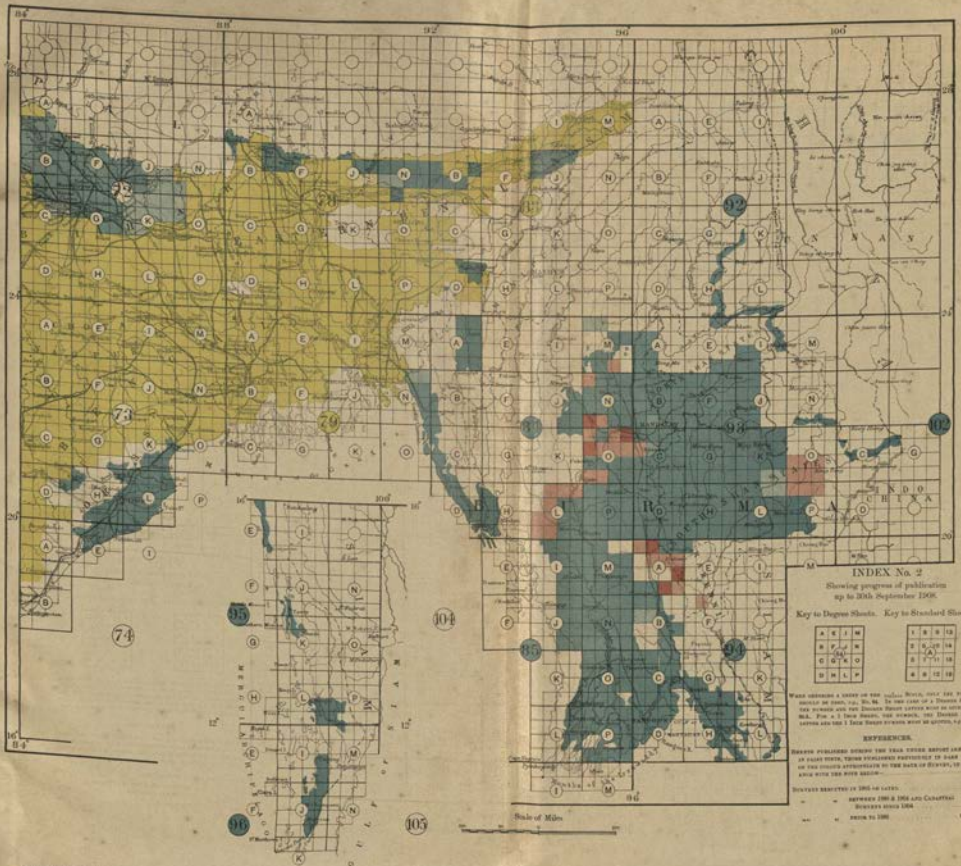
Showing progress of publication up to 30th September 1908.
Key to Degree Sheets. Key to Standard Sheets.
Scale of Miles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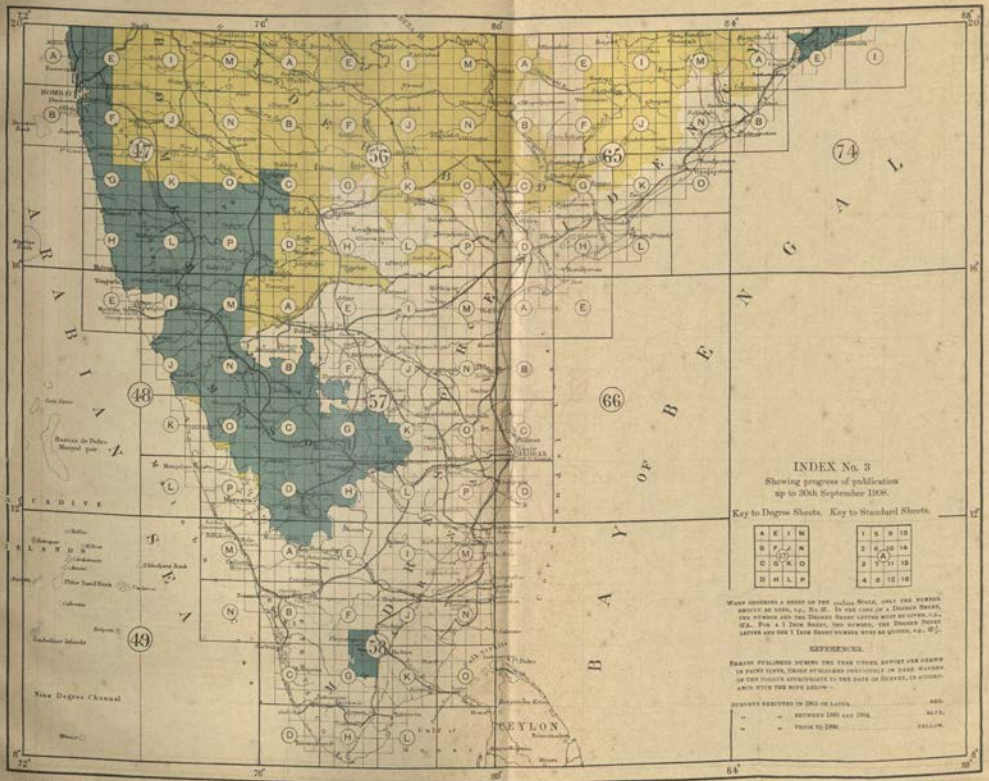
Key to Standard Sheets
REFERENCES.
Scale of Miles.


INDEX No. 3
Showing progress of publication
up to 30th September 1908.
Key to Degree Sheets. Key to Standard Sheets.
REFERENCES.
Scale of Miles
ARABIAN SEA
BAY OF BENGAL
LACCADIVE ISLANDS
CEYLON
Nine Degree Channel
Bassas de Pedro Mosyal par
Gulf of Mannar
BOMBAY
47
48
49
56
57
58
65
66
74

PART II.

THE OPERATIONS OF FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 Party.

82. The party was under the charge of Captain C. M. Browne, D.S.O., R.E., throughout the year under report and was divided into three detachments.

Personnel.

Western Baluchistán detachment.

Imperial Officer:

Captain C. M. Browne, D.S.O., R.E., in charge.

Provincial Officers:

Messrs. F. W. Smith and G. A. Norman, and Babu Mohan Lal Arora, from 22nd August 1908.

Burma detachment.

Imperial Officer:

Lieutenant E. B. Cardew, R.E.

Provincial Officers:

Munshi Abdul Hai, and Mr. V. D. B. Collins.

Northern Baluchistán detachment.

Imperial Officer:

Lieutenant G. F. T. Oakes, R.E., from May 1908.

Provincial Officers:

Messrs. C. H. Tresham and V. P. Wainright.

83. *Western Baluchistán.*—The programme was to complete the Kalát longitudinal series up to the Persian border. The detachment under Captain Browne assembled at Nushki on the 27th October and on the 4th November left for Padag.

84. Captain Browne revised the angles at two stations (Kopadhar and Pulchotau of the old figure Kopadhar-Pulchotau-Pragi-Kisanen Chapper) where an abnormal triangular error had been found in 1904-05. He then proceeded to Shuri where the work had been discontinued the previous year, arriving there on the 17th December; he observed an astronomical azimuth at Tuzgi. New stations were built at Borghar, Garrukki Gori, Maland Koh, Kacha Koh, Lar Koh, and at Koh-i-Malik Siah (trijunction point of Afghánistán, Persia, and Baluchistán). An astronomical azimuth was observed at Koh-i-Malik Siah.

Mr. Tresham having in the meantime triangulated to Robat, an astronomical determination of the latitude of Robat was made by the method of circum-meridional altitudes.

Field work was then closed and the detachment began its long return march of 400 miles to Nushki arriving there on the 10th May.

85. The Kalát series which has now been finished is approximately 480 miles long from its origin on the Indus to its terminus near Persia, and it embraces an area of 11,000 square miles within its triangles. It is of interest to compare the accuracy of this Kalát series, which is the latest triangulation of the Trigonometrical Survey of India, with the most recent geodetic work of other countries. The relative accuracies of different surveys may be compared by means of their respective probable errors, the smaller the probable error the greater the accuracy of the survey.

If, in any triangulation, N be the number of triangles, and $\Sigma\Delta^2$ the sum of the squares of the triangular errors, and if E be the probable error of an observed angle, then $E = \frac{2}{3}\sqrt{\frac{\Sigma\Delta^2}{3N}}$.

This formula gives for the Kalát series

$$E = 0''.21.$$

In the recent geodetic triangulation of Rhodesia
E was o″·44.

In the triangulation of Cape Colony E was o″·34, and in the triangulation on the 98th meridian of the United States of America, E was o″·48.

The Kalát series has taken four years to complete, the observers being Captain H. H. Turner, R.E., and Captain C. M. Browne, D.S.O., R.E. Of the 51 triangles only three have an error exceeding 1″.

Five astronomical azimuths have been observed at different points of the series; and, if we compare the astronomical values with the values computed from the triangulation, the latter are always found to be too large. The persistency of the excess is a warning to us that our computations are taking the triangulation too far to the north. The error of direction is being gradually accumulated as we get further from the centre of India, because our formulæ for triangulation are derived from a spheroid, which is appreciably smaller than the true figure of the earth.

The westernmost station of the Kalát series is Koh-i-Malik Siah, the trijunction point of India, Persia, and Afghánistán: this point is of interest both from its political importance and from its being the most westerly limit now reached by the Principal Triangulation of India. The astronomical azimuth at this place differs from the value computed through the triangulation by 13″·04, the largest positive difference that has been discovered during the Indian observations. The value of latitude, hitherto accepted for Koh-i-Malik Siah, was found to be 1″·84 too great and the value of its longitude 4″·879 too great; the position on the earth, assigned to Koh-i-Malik Siah, was thus 468 feet in error.

An interesting mountain fixed with care from no less than 10 stations was Koh-i-Taftan. Its summit is formed by two main peaks of nearly equal height, the southern and higher being still an active volcano in more or less constant eruption.

Koh-i-Taftan is a very conspicuous landmark being visible on clear days from the whole country within 150 miles radius: no point within 300 miles of it approaches it in altitude, and it is covered with snow for nearly the whole year.

Its distance from the sea (about 250 miles) is, it is believed, the greatest of any active volcano in the world.

The co-ordinates of the two main peaks of Taftan are (*a*) south-west peak, (active volcano), latitude 28° 36′ 0″·49, longitude 61° 10′ 28″·14, height 12,973; (*b*) north-east peak, latitude 28° 36′ 28″·63, longitude 61° 9′ 54″·00, height 12,935.

The geographical positions hitherto assigned to the peaks of Taftan were found by Captain Browne to be in error by over 600 feet, the old positions being north-east of the true.

To the north-west of Taftan are several extinct volcanoes, and the whole region is a most curious mixture of aqueous and igneous deposits. The volcano of Koh-i-Sultán, on which Captain Browne observed for 10 days in 1907, is dying, but is not quite "dead"; though its huge crater is now floored with *débris* and silt, Captain Browne found his theodolite constantly disturbed by the tremors and pulsations of the mountain.

86. *Northern Baluchistán detachment.*—At Nushki Captain Browne was joined in May 1908 by Lieutenant Oakes and Mr. Wainright, and a new detachment was organised for work in the hot weather in Toba from men enlisted by Mr. Wainright with a nucleus of old men. Lieutenant Oakes took charge of this detachment.

87. *Northern Baluchistán detachment.*—Lieutenant Oakes commenced a new series of principal triangulation called the Northern Baluchistán series; he started observations from the side Zawa-Zibra of the Kalát longitudinal series and worked northwards to the Toba plateau; in Toba the series will turn to the north-east and will follow the Afghán boundary: it will eventually join the Great Indus series near Sheikh Budin, and will thus bring the immense frontier area between the Khojak and the Indus under the trigonometrical control of the principal triangulation of India. The stations for the first two figures north of Zawa-Zibra were built during 1906-07. The party assembled at Mastung road on the 13th May 1908, and started for Zawa on the 21st May. As the work is still in progress it is not possible to give a detailed account of the results.

The figure on which the detachment is now engaged covers an immense area; one of its sides is more than 68 miles long and is the longest side of any triangle of the Great Trigonometrical Survey of India; this long side has been successfully observed from one of its terminals. A detailed report of the outturn of the work of this detachment will be given in next year's report.

88. *Burma detachment.*—The programme of the Burma detachment was to re-start the Great Salween series from the point where it had been stopped by Captain Wood, R.E., in 1902-03; the direction of the series was slightly changed and made to conform to the British boundary. The detachment proceeded to Burma and started from Lashio on the 14th November. The stations that had been built for the first two figures under Captain Wood in the year 1903 were retained, the direction of the series being changed near latitude 22°.

The first work was to complete the figure begun by Captain Wood in 1903 and this entailed observations from Loi Hsāmhsip and Loi Ai-Hpang: Lieutenant Cardew then took observations at the following new stations of the series Loi Kangmong, Loi Taow, Loi Maw, Loi Ling, and Loi Hpa-tan.

At the last-mentioned station an astronomical azimuth was observed, and the difference between the geodetic and the observed values is in accordance with those previously found in this region. Towards the latter part of the season the work was greatly hindered by dust-haze. During the winter Mr. Collins selected and built all the stations that will be required to extend the triangulation to longitude 99° 23′. After the return of the party to India a small detachment was formed for work in the Dehra Dún district in continuation of the work done in 1907, and Lieutenant Gwyn, I.A., was attached for instruction.

89. The following statement shows the outturn of work of the Western Baluchistān and Burma detachments:—

STATEMENT OF OUTTURN OF WORK.

Western Baluchistán detachment.

Number of the Principal Stations at which observations were taken	10
Number of the Principal Stations newly fixed	6
Length of new series in miles	107
Area of triangulation in square miles	2,373
Average triangular error of 13 triangles	0″·35
Value of Astronomical-Geodetic Azimuth at Tuzgi	+6″·77
" " " " at Kohi-Malik Siah	+13″·04

Burma detachment.

Number of Stations at which observations were taken	7
" " newly fixed	5
Length of series in miles	55
Area in square miles	1,800
Average triangular error of 14 triangles	0″·64
Value of Astronomical-Geodetic Azimuth at Loi Hpa-tan	−8″·01

SCIENTIFIC OPERATIONS.

GEODETIC.

ASTRONOMICAL LATITUDES.

No. 22 Party.

90. From November 1907 till January 1908, this party was employed under Captain Cowie, R.E., in carrying out, in co-operation with No. 23 Party under Major Lenox-Conyngham, R.E., comparisons between the Standard Bar A of the Indian Survey and the two Bars I_B and I_S. From January till the end of the field season the party was engaged in taking observations for the determination of latitude and of the deflection of the plumb-line.

Personnel.

Imperial Officers:

Captain H. M. Cowie, R.E., in charge.
Mr. J. deGräaff Hunter, M.A., under instruction (for part of season).

91. In view of the employment in the near future of a 4-metre Standard Invar Bar for the measurement of geodetic bases in India, in place of the Standard 10-foot Bar A, the Superintendent of Trigonometrical Surveys considered it advisable to send the latter to Europe for comparison with the metre, and as a precautionary measure, to compare it at Dehra Dún with the Bars I_B and I_S before its despatch to Sèvres.

92. Forty-two sets of comparisons were made by Major Lenox-Conyngham and Captain Cowie between the Bars A and I_S, the temperature during the observations ranging from 6°.88 above to 5°.37 below 62°F. Thirty-eight sets of comparisons were made between A and I_B, the range of temperature being from 7°.13 above to 6°.34 below 62°. The results of the observations were—

I_S—A at 62° F.=83·12 millionths of a yard, the mean temperature of the observations being 61°·7.

I_B—A at 62° F.=196·73 millionths of a yard, the mean temperature of the observations being 61°·1.

000. The comparisons made in 1867 and 1870 gave as a mean value—

I_S—A at 62° F.=82·52 millionths of a yard, the mean temperature of observation being 61°·9.

The difference between the old and new values is thus, only 0·60 millionths of a yard, a quantity a little greater than one-six millionth part of the length of Bar A.

No direct comparison was made in 1870 between Bars A and I_B, but by combining Clarke's value of I_B—I_S, determined about 1865 with the mean 1867—70 value of I_S—A, we can deduce a value for I_B—A.

Clarke's value of I_B—I_S=131·46 millionths of a yard.

1867-70 value of I_S—A=82·52 ,, ,,

Deduced value of I_B—A=213·98 ,, ,,

The difference between the old and new values is, in this case, 17·25 millionths of a yard, or about one-two hundred thousandth part of the length of Bar A.

When we take into consideration the nature of the defining marks of Bar A, made about the year 1830, the close agreement between the old and new values must be looked upon as fortuitous to a great extent. The smallness of the differences given above is evidence that the length of the Bars have not altered materially since 1870.

93. On the conclusion of the comparisons at Dehra, Bar A was sent by the Superintendent, Trigonometrical Surveys, to Sèvres. The result of the comparisons carried out there have lately been received from M. Guillaume, Deputy Director of the Bureau International des Poids et Mesures. The value of Bar A in terms of the metre proved to be, at 62° F.

3047·9988 mm.

From Clarke's determination made about the year 1864,

Bar A at 62° F.=3.33331886 standard yards.

Converting this into terms of the metre by means of the equivalent determined at the Bureau International des Poids et Mesures, M. Guillaume finds—

Bar A at 62°F. (1864)=3047·9841 mm.

The difference between the old and new values is

0·0147 mm.

or about 13·12 millionths of a yard.

The differences shown above between the old and new values are, in every case, very small when it is considered how difficult it is to make an intersection, satisfying modern ideas of precision, of the defining marks of Bar A, which though held to be good at the time of its construction, must now be looked on as unsatisfactory in comparison with the best modern designs.

94. On conclusion of the comparisons between Bars A, I_B and I_S, normal latitude operations were undertaken by Captain Cowie in the country to the south and east of Deesa. Six principal stations were visited, four on the Abu meridional series and two at the junction of the Karachi longitudinal series and the Singi meridional series.

Mr. J. deG. Hunter, M.A., was with the party during the latter part of the season, and took a duplicate set of observations at the stations of Kárdo and Dhámanva.

95. The results of the season's work are tabulated below :—

TABLE.

Station.	Longitude.	Height above M. S. L.	Astronomical Latitude.	Seconds of Geodetic Latitude.	Deflection.
	° ′	Feet.	° ′ ″	″	″
Moráli . . .	73 0	466	23 25 17·47	23·18	—5·71
Dhámanva . .	72 33	399	23 32 2·66	8·40	—5·74
Kaináth . .	73 1	1,385	23 51 14·99	23·79	—8·80
Kárdo . . .	72 46	807	23 57 2·17	10·02	—7·85
Lakarwás . .	73 52	2,574	24 31 41·05	47·99	—6·94
Tiki . . .	73 53	2,369	24 55 34·52	38·24	—3·72

96. The season's programme was designed to throw light on questions concerning the abnormally high deflection found to exist at Chaniána, about 23 miles east of Deesa. The results given above show that to the south of Chaniána, we have the same decrease in the value of the deflection that occurs to the north and west. In every direction the northerly deflection is found to diminish rapidly. Captain Cowie draws the conclusion that the disturbing influence, to which the high value at Chaniána is due, originates "in a purely local cause, situated "either at the surface or at a small distance below it."

He is of opinion that, if a deflection still greater than that at Chaniána does exist, we shall have to look for it to the north-east of that station.

PENDULUM OPERATIONS.

No. 23 Party.

97. Between November 1907 and January 1908 this party was employed in co-operation with No. 22 Party in making comparisons between the standard Bar A and the reference Bars I_B and I_S. The results of the comparisons will be found in the report of the work of No. 22 Party. Between January and the end of the field season the party visited seven places in Southern India and made determinations of the force of gravity, with the object of ascertaining whether in sub-montane tracts in the south of India, this force would be found to be in defect to the same degree as it is in the neighbourhood of the Himalayas.

Personnel.

Imperial Officers:

Major G. P. Lenox-Conyngham, R.E., in charge until 5th May 1908.

Captain H. M. Cowie, R.E., in charge from 6th May 1908.

Mr. J. deG. Hunter, M.A., under instruction (for part of the season).

Provincial Officer:

Babu Hanuman Prasad.

98. In addition to the standardization observations made in Dehra at the commencement and the end of the field season, the pendulums were swung at the following stations :—

Mysore . . . . . } on the Mysore plateau.
Bangalore . . . . . }
Kolar, Edgar Shaft, at the surface . . . }
" " " at the bottom of the shaft }
Ootacamund, on the Nilgiri Hills.
Yercaud, on the Shevaroy Hills.
Kodaikánal, on the Palni Hills.
Salem, at the foot of the Shevaroy Hills.

99. The results of the season's work are given in the following table. The orographical corrections applied in computing the final values of g were found to be of significant amount at all stations except Bangalore and Mysore. Except in the case of Kodaikánal, these corrections are based on a detailed examination of the surface masses within 35 miles of the station. In the case of Kodaikánal this investigation was not possible beyond 1 mile from the station on account of the want of suitable maps.

TABLE.

Station.	Latitude.	Height above Mean sea-level.	Observed value of gravity=g.	g reduced to sea-level =g_o''.	Theoretical value at sea-level=γ_o.	$g_o''-\gamma_o$.	Degree of compensation of visible masses.
	° ′ ″	Feet.	Dynes.	Dynes.	Dynes.	Dynes.	Per cent.
Mysore .	12 18 52	2,501	978·045	978·191	978·236	−0·045	51
Bangalore .	13 0 41	3,118	978·025	978·206	978·263	−0·057	52
Edgar Shaft underground	12 55 46	328	978·133	978·238	978·260	−0·022	...
Edgar Shaft surface.	12 55 47	2,945	978·076	978·247	978·260	−0·013	3
Ootacamund .	11 24 37	7,395	977·735	978·171	978·203	−0·032	12
Yercaud .	11 46 56	4,493	977·908	978·180	978·217	−0·037	23
Kodaikánal .	10 13 50	7,665	977·643	978·092	978·164	−0·072	27
Salem . .	11 40 5	948	978·116	978·172	978·212	−0·040	120

100. The following conclusions may be drawn from the results of the table:—(*a*) The deficiency of gravity is considerably less at these stations than at places in the north of India which are similarly situated as regards height above mean sea level; (*b*) at the stations of Ootacamund, Yercaud, and Kodaikánal, situated on what may be termed "isolated" masses, the *degree* of compensation of the visible mass is much less than it is at stations on the extensive Himalayan mass; (*c*) at Bangalore and Mysore, situated *on the plateau*, the *degree* of compensation is considerably greater than at Yercaud, Kodaikánal and Ootacamund, which, though higher, are upon "isolated" masses. (The results at Kolar on the plateau do not, however, accord with those at Mysore and Bangalore).

Captain Cowie draws the general conclusion that the extent of the deficiency is independent of the height of the visible mass.

At Kodaikánal, only a little higher than Ootacamund, the degree of compensation is more than twice as great. At Yercaud, at rather more than half the height of Ootacamund, the compensation is almost twice as great. Had we found that the degree of compensation was a function of the height of the visible mass, we might have concluded that the attenuation of density causing these deficiencies of gravity occurred within the visible masses. As it is, we have been led to infer that it is principally the subjacent masses that affect the compensation of those visible at the surface.

101. The time observations were made satisfactorily throughout the season, by Babu Hanuman Prasad, using for the first time the new bent Transit Instrument. The average probable error, for the season, of a value of the clock rate was $\pm 0^s{\cdot}014$.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

Personnel.

Imperial Officer:

Mr. C. F. Erskine, in charge.

Provincial Officers:

Messrs. J. P. Barker, H. G. Shaw, E. H. Corridon, Munshi Syed Zille Hasnain, Mr. A. M. Talati, Mr. O. N. Pushong, Babu P. N. Sur and Mr. D. H. Luxa.

102. Mr. C. F. Erskine held charge of the party throughout the year.

Subordinate Establishment.

1 Surveyor, 23 Computers and Recorders, 2 Native Artificers, 4 Tidal Observatory Clerks.

Tidal Operations.

103. Observations were taken by means of self-registering tide-gauges during the year at the stations enumerated in the following list:—

Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1 *Aden*	1879	Still working.	28	
2 *Karachi*	1881	„ „	27	
3 *Bombay (Apollo Bandar)*	1878	„ „	30	
4 *Bombay (Prince's Dock)*	1888	„ „	2	Property of Port Trust.
5 *Madras*	1880 restarted 1895	1890 Still working.	10 13 (23)	
6 *Kidderpore*	1881	„ „	27	
7 *Rangoon*	1880	„ „	28	
8 *Port Blair*	1880	„ „	28	

104. In addition to the above, readings to tide-poles were taken at Bhávnagar, Chittagong, Akyab, and Moulmein.

105. The eight tidal observatories at work were inspected during the year, and the registrations have been entirely satisfactory.

106. In the following tables are given the annual and decadal percentages of the predicted time and height errors of high and low water at open coast and riverain stations:—

Percentage of errors in Predicted Times and Heights at open coast stations from Automatic Registrations.

Year.	Number of Stations.	In time. Within 15 minutes of actuals.		In height. Within 8 inches of actuals.		In height. Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1898	9	74	70	96	96	95	95
1899	9	74	66	95	95	93	92
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
1905	7	82	79	96	95	96	97
1906	6	85	81	96	97	94	95
1907	6	84	83	98	98	98	99
Average of 10 years	8	77	72	95	95	95	94

Percentage of errors in Predicted Times and Heights at Riverain stations from Automatic Registrations.

Year.	Number of Stations.	In time.		In height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
1905	2	52	62	72	57	94	92
1906	2	59	53	74	64	92	95
1907	2	58	47	78	60	96	90
Average of 10 years	2	56	58	73	60	92	91

107. The tidal observatory cabin at Moulmein was erected in August. The tide-gauge and other instruments will be installed before the end of the year and registrations will be commenced by 1st January 1909. Moulmein will then become a permanent tidal station.

Levelling Operations.

108. There were three detachments engaged on the levelling operations during the year under report.

109. No. 1 Levelling detachment was employed on revision levelling, the work executed by them being from Guntakal to Madras. Standard Bench-marks were connected at Cuddapah and Madras. The outturn amounted to 296 miles. The field season commenced on 11th October and ended on 13th April.

110. No. 2 detachment ran a line of levels from Ferozepore to Nágaur on the Jodhpur-Bikaner Railway. The Standard Bench-mark at Bikaner was connected *en route*. Three Great Trigonometrical Stations were connected. The Standard Bench-marks at Dera Ismail Khan and Multán were also connected with adjacent lines of levelling. The total outturn of levelling was 348 miles. The field season commenced on 12th October and ended on 12th April.

111. No. 3 detachment was employed on revisionary work between Kosgi and Guntakal, and between Bellary and Kárwár. This detachment also connected the Standard Bench-marks at Ráichur and Bellary. The season's outturn amounted to 297 miles. The duration of the field season was from 12th October 1907 to 1st May 1908.

The total outturn of double levelling during the field season was 941 miles, in the course of which observations were taken at 12,094 stations. The Bench-marks determined were 8 Standard, 70 Embedded, 667 Inscribed, and 25 belonging to other departments.

Thirty-two Standard Bench-marks were erected and 13 connected, 15 are under construction, and 28 have been proposed for erection. During the past year 265 Bench-marks were reported as lost.

112. The old line of levels between Bombay and Madras, which was executed 30 years ago, exhibited a closing error of 2·98 feet, Madras being placed 2·98 feet higher by this levelling from Bombay than it had been shown to be by tidal observations taken in its own harbour. The 800 miles of levelling from

Madras to Bombay have now been revised, and the new revisionary line has closed at Madras with an error of +0·607 foot.

The closing error has thus been reduced by 2·37 feet, from 2·98 to 0·607. General Walker, who was Surveyor General of India from 1879 to 1883, always maintained that the discrepancy of 2·98 feet at Madras was due to a steady and imperceptible accumulation of levelling error: the recent revision has shown that his view was entirely correct, and has disproved the theory that the mean sea level at Madras was actually higher than at Bombay.

113. During the approaching field season of 1908-09, No. 1 Levelling detachment will be employed in connecting the Standard Bench-marks at Sátára, Belgaum, Bijápur, Bangalore, Salem, Calicut, Trichinopoly, Negapatam, Madura, Tinnevelly, and in Secunderabad, with adjacent lines of levels, and then on the Katni-Secunderabad line of levelling, commencing from Secunderabad.

114. No. 2 Levelling detachment will be employed in completing the Ferozepore-Ahmedabad line of levels, in running a short line of levels from Pálanpur to Deesa, and in connecting the Standard Bench-marks at Jodhpur, Deesa, and Ahmedabad.

115. No. 3 Levelling detachment will be employed on the Katni-Secunderabad line of levelling commencing from Katni, and also in connecting the Standard Bench-marks at Saugor, Jubbulpore, Nágpur, Raipur, Bilaspur, Sambalpur, Akola, and Hinganghát, with adjacent lines of levels.

116. In addition to the levelling executed during the field season by the three levelling detachments, the following minor lines of levels were completed:—

(*i*) From Nojli Trigonometrical Survey to Myapore Canal Bungalow, Hardwár, 38 miles.

(*ii*) From Great Trigonometrical Survey Office, Dehra Dún, to Kálsi Bridge, over the Jumna River, 31 miles.

117. The levels, used by the Survey of India, have shown themselves trustworthy instruments, but they are of ancient pattern, and since they were made, undoubted improvements have been devised. At the International Geodetic Conference, which met at Copenhagen in 1905, the Superintendent of the Geodetic Survey of the United States of America exhibited a new pattern of level, which seemed to be a great advance upon all previous patterns. Two of these American levels were bought for the Survey of India, and have been tried during the last two winters. The trials were entirely successful; and it will now be possible to work both more quickly and more accurately.

The device by which the speed of levelling can be increased is a very simple one: the telescope of the level is furnished with three intersecting wires instead of one. At each pointing of the level, the staff can thus be read in three places simultaneously, instead of in one. This arrangement dispenses with the necessity both of chaining from the level to the staff, and of reading the two faces of the staff. We can now deduce the distance of the staff from the readings of the wires upon it; and the risk of reading the staff incorrectly to a whole foot is entirely eliminated by the triplication of the wires. It was merely to obviate this risk that staves were originally given two differently graduated faces. The operation of reversing the faces of the staves greatly prolongs observations, and is a troublesome step, that the levelling officers will gladly see dispensed with.

The plan by which the accuracy of levelling can be increased has been designed to get rid of the errors, that are caused by the observer walking round his level, when he wishes to read the bubble after observing with the telescope. When an observer transfers his weight from one side of a level to another, the ground sinks as he approaches and recovers as he departs, and the bubble of the level responds to these disturbances. The observer is therefore always liable to read his bubble, when it is in a different position to what it was at the instant of his telescopic observation. In the American levels this liability to error has been eliminated: these levels are binoculars, and the two telescopes are viewed simultaneously; one telescope shows the image of the staff with the cross wires upon it, and the other telescope shows the image of the level bubble by reflection. It is easy now to watch both the staff and the bubble at the same instant.

MAGNETIC OPERATIONS.

No. 26 Party.

118. *Field Operations. Work of the field detachments.*—During the year four detachments continued the preliminary Magnetic Survey, three being employed in Burma, while the fourth was occupied in filling in gaps in Berar, Orissa, and Assam. One of the Burma detachments was withdrawn from magnetic work for three months in order to carry out some triangulation for the Chin-Lushai-Arakan boundary, and another, owing to the early break of the monsoon in South Burma, could not complete its programme. For these reasons the outturn of new stations, 80, was small compared with the 152 stations of the previous year.

Personnel.

Imperial Officers:

Captain R. H. Thomas, R.E., in charge up to 31st March 1908.
Lieutenant H. J. Couchman, R.E., in charge from 1st April 1908.

Provincial Officers:

Mr. E. C. J. Bond, Mr. H. P. D. Morton, Babu R. P. Ray, Babu N. R. Mazumdar, and R. B. Mathur.

Subordinate Establishments:

2 Observers, 13 Recorders, 1 Computer, 2 Surveyors and 1 Writer.

The field season commenced on the 21st October 1907, and the party proceeded to recess quarters on the 4th May 1908.

119. *Work of the Imperial Officers.*—The Officer in charge, with his assistant, took observations at all the repeat stations and also at several old field stations, with a view to obtaining further values of the secular change in the magnetic elements. Comparative observations were also taken at the four observatories of the Survey, and at Alíbág, to determine the differences from the Survey standard instruments at Dehra Dún.

The new Vertical Force magnets, referred to in the last report, were mounted at Barrackpore and Kodaikánal observatories in December 1907, and satisfactory determinations of their temperature co-efficients made, the values found being $-3{\cdot}0\gamma$ and $+5{\cdot}2\gamma$ per $+1^{\circ}$F. respectively.

120. *Total work to date.*—The total number of stations occupied to date is 1,214 with 22 repeat stations; observations have also been repeated at 31 old field stations.

121. *Work during recess.*—During the recess season the computation of the field work and the reduction and tabulation of the base station results for 1907 have been completed. The whole of the H. F. observations taken since the beginning of the survey have been re-computed by applying a mean value of m, (the moment of the magnet), to the value of $\frac{m}{H}$ obtained in the deflection observation. The mean values of m have been obtained by dividing the values into groups and taking means of groups. Where the means of several groups agree a further mean has been taken and where not the individual values have been carefully scrutinized to discover when the change occurred. This re-computation was undertaken originally to improve the monthly mean values of the base lines of H. F. magnetographs, and as this was achieved, the method has been extended to all H. F. observations, and has provided new values of the instrumental differences, which will be used in the reduction.

The correction of the horizontal force and declination observations for diurnal variation and instrumental difference is being started, the repeat stations being dealt with first. The diurnal variation correction to be applied will be computed by the latitude formula mentioned in the last report, using the diurnal variation figures of the three nearest base stations, and taking a mean of the two values of the correction found. With regard to the instrumental correction in horizontal force it is to be noted that such correction cannot be expressed as a constant in absolute units, but is of the form, fH, and its amount will consequently vary slightly over the area of the survey.

Investigations into the question of the disturbance correction are still being made, but no satisfactory empirical formula, connecting these corrections at the base stations, has as yet been discovered, and it would seem that an approximate correction will have to suffice, for, at any rate, the horizontal force observations.

122. *The Base stations.*—With the exception of the Kodaikánal V. F. instrument the magnetographs have given good results throughout the year.

This instrument, however, still appeared to be unstable even after the mounting of the new magnet, and this is probably due to the very low value of dip, 3°N., found at this station. In taking dip observations in low magnetic latitudes, the difficulty of placing the dip circle in the magnetic east-west direction, when the needle assumes the vertical position, has always been experienced, a slight alteration in azimuth causing the needle to depart from the vertical. The case of the V. F. magnetograph at Kodaikánal is similar, a slight azimuthal displacement of the magnet, when lifted and lowered on the agate plane, causing it to take up a position sensibly inclined to that to which it has been brought by means of counterweights. The magnet has, however, been made more stable by lowering the small gravity bob and excellent results are now being obtained, and it is hoped that no further difficulties will be experienced. The base-mirror of the declination magnetograph at Barrackpore has been renewed, the old one having been attacked by fungoidal growth.

123. *The mean values of the Magnetic elements at Observatories for 1907.*—The mean values of the magnetic elements at the four observatories o the survey for 1907 are as follows:—

Dehra Dún	Lat. 30° 19′	Long. 78° 3′.
Declination	2° 38′·3 E.	
Dip	43° 36′·1 N.	
H. F.	·33324 C. G. S.	
V. F.	·31736 C. G. S.	
Barrackpore	Lat. 22° 46′	Long. 88° 22′.
Declination	1° 9′·9 E.	
Dip	30° 30′·2 N.	
H. F.	·37288 C. G. S.	
V. F.	·21967 C. G. S.	
Toungoo	Lat. 18° 56′	Long. 96° 27′.
Declination	0° 39′·3 E.	
Dip	23° 0′·7 N.	
H. F.	·38754 C. G. S.	
V. F.	·16461 C. G. S.	
Kodaikánal	Lat. 10° 14′	Long. 77° 28.
Declination	0° 40′·7 W.	
Dip	3° 27′·2 N.	
H. F.	·37431 C. G. S.	
V. F.	·02259 C. G. S.	

124. *The Isomagnetic charts.*—The three isomagnetic charts published in this report show the lines of—

(1) Equal declination (isogonals)
(2) Equal dip (isoclinals)
(3) Equal horizontal force,

and are based on the uncorrected observations of the preliminary survey. They can, therefore, only be regarded as approximate, more especially as regards the size of the abnormal areas enclosed by "ring contours." The correct delineation of these areas must await the completion of the detail survey, and at present their locality is indicated only.

An approximate correction for secular change has been applied, and to minimise the effects of errors in this correction, the middle year of the survey, 1905, has been selected as the epoch.

The lines of equal secular change in declination are shown on the isogonal chart, except in Burma, where, at present, the data are insufficient. The secular changes in dip and in horizontal force have not as yet been determined with sufficient accuracy to enable the lines to be drawn.

In the declination chart, the chief point of interest is the very slow rate of change with latitude in Burma, as shown by the increased width of the belt 1° E to 0°. The agonic line which leaves India near Masulipatam apparently passes through Sumatra. It will be noticed that the declination varies little with change of longitude and the terrestrial isogonals will probably be found to run due east and west.

The dip chart calls for little comment as the isoclinals are extremely regular over the whole area. In dip the values which differ by more than 1° from the normal are very rare, whereas in declination they are fairly common. It will be

noticed that the magnetic equator cuts the extreme south of India and is at present slowly moving south.

The lines in the horizontal force chart are also regular, and there is little to note in the north of India. The lines in south India and Burma, however, call for some remark owing to the greater intensity of the horizontal force in the latter country. The magnetic equator crosses India along latitude 9°, and the horizontal force will presumably decrease as we proceed further south; the two southern belts in Burma must therefore disappear before they reach India, and the 0·385 and 0·395 lines must presumably be closed curves. This view is supported by the values of horizontal force found in Sumatra during the magnetic survey of the Dutch East Indies, those in the north of the island being about ·391, and those in the centre ·386.

125. *Work projected for 1908-09.*—During the next field season it is intended to begin the detail survey by examining a few of the more obviously disturbed districts in Rajputana and Central India. One such district occurs near Pokaran, in the Rajputana desert, where the declination alters by 3° in 40 miles, while another lies near the Nerbudda river south-west of Indore, where values of horizontal force of ·32 C. G. S. and ·38 C. G. S. have been found at contiguous stations, 35 miles apart, the normal value of the district being about ·365 C. G. S. It is considered advisable to commence the detail survey in these abnormal localities, in order to gain experience in selecting stations which will reveal the loci of disturbance, and not to attempt, as yet, to pourtray the geological features of a district, which has not been shown as obviously abnormal by the uncorrected observations of the preliminary survey. The survey of the northern edge of the Deccan trap, mentioned in last year's report, will therefore be left for the present. Two detachments will be available for the detail survey throughout the field season. Two others will be employed in completing the preliminary survey of the coast of Burma for the greater part of the season, and will then assist in the detail survey.

126. A table showing the approximate preliminary values (uncorrected) at the field and repeat stations in 1907-08 is appended, together with a reference chart showing all the stations of observations to date.

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season 1907-08.

Serial No.	Name of station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
1135	Möng Mā	3	22 45 10	98 16 10	30 52	E 0 52	0·3773	H. is derived from Mean M°. throughout.
1136	Möng Vai	„ 4	22 25 30	98 2 30	30 18	„ 0 53	0·3784	
1137	Möng Awt	„ 5	22 2 20	98 22 30	29 32	„ 0 51	0·3799	
1138	Hsupwo	„ 6	21 49 50	98 50 20	29 6	„ 0 49	0·3806	
1139	Möng Ping	1	21 21 0	99 1 10	28 10	„ 0 45	0·3823	
1140	Kēng Tung	„ 2	21 17 0	99 37 0	28 2	„ 0 45	0·3820	
1141	Möng Yāng	„ 3	21 50 40	99 41 30	29 10	„ 0 41	0·3802	
1142	Hsoplamhsoplwe	„ 4	21 23 40	100 14 20	28 16	„ 0 44	0·3822	
1143	Nam Láng (Paliao).	1	20 49 50	100 20 50	27 7	„ 0 47	0·3842	
1144	Möng Hai	„ 2	20 46 10	99 48 10	26 59	„ 0 45	0·3839	
1145	Möng Hsāt	„ 3	20 31 40	99 15 50	26 27	„ 0 47	0·3845	
1146	Möng Tung	1	20 18 0	98 54 10	25 58	„ 0 45	0·3850	
1147	Möng Htá	„ 2	19 51 10	98 34 0	25 0	„ 0 44	0·3860	
1148	Möng Pan	„ 3	20 19 10	98 22 10	26 0	„ 0 45	0·3845	
1149	Möng Nai	„ 4	20 30 20	97 52 0	26 19	„ 0 41	0·3843	
1150	Keng Tawng	„ 5	20 45 10	98 18 10	26 51	„ 0 45	0·3838	
1151	Möng Pu	„ 6	20 54 40	98 44 30	27 15	„ 0 48	0·3830	
1152	Wán Kawng	7	21 23 20	98 22 30	28 13	„ 0 48	0·3820	
1153	Wán Hoko	„ 8	21 0 10	97 57 0	27 22	„ 0 44	0·3829	
1154	Wán Hohwe	„ 9	21 9 0	97 34 40	27 39	„ 0 46	0·3822	
1155	Nawnglayáw	„ 10	21 38 20	97 44 30	28 38	„ 0 47	0·3810	
1156	Man Li	„ 11	22 5 50	97 31 30	29 38	„ 0 48	0·3796	
1157	Kyawkku	17	21 48 20	96 56 10	29 0	„ 0 48	0·3805	
1158	Lawk Sawk	„ 18	21 14 40	96 52 30	27 52	„ 0 45	0·3817	
1159	Taunggyi	7	20 46 30	97 2 50	26 53	„ 0 49	0·3837	
1160	Kálaw	10	20 37 40	96 34 10	26 33	„ 0 45	0·3835	
1161	Sillod	9	20 18 40	75 38 50	25 21	„ 0 11	0·3690	
1162	Deulghát	„ 10	20 32 0	76 7 10	26 10	„ 0 33	0·3647	

Statement showing approximate magnetic values at stations observed at by No. 26 Party during season 1807-08—contd.

Serial No.	Name of station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
1163	Mehkar	39/77 11	20 9 10	76 35 10	25 48	E 0 47	0·3656	
1164	Chikni	39/78 13	20 5 0	77 53 30	25 6	„ 0 31	0·3708	
1165	Boraghat	39/82 13	21 31 40	84 33 30	28 15	„ 0 59	0·3750	
1166	Bonáigarh	„ 14	21 49 0	84 57 30	28 54	„ 0 25	0·3729	
1167	Pal-Lahára	39/83 6	21 25 50	85 11 30	27 51	„ 0 31	0·3739	
1168	Tálcher	39/85 7	20 57 10	85 14 30	27 2	„ 0 58	0·3768	
1169	Kantolo	39/86 7	21 7 20	85 37 40	27 54	„ 0 45	0·3735	
1170	Gutgaon	„ 8	21 24 10	85 53 20	27 52	„ 0 52	0·3753	
1171	Keonjhar	„ 9	21 37 40	85 35 30	28 15	„ 0 49	0·3740	
1172	Jaintigarh	„ 10	22 4 10	85 40 40	29 8	„ 1 4	0·3727	
1173	Chaibassa	„ 11	22 32 30	85 48 30	30 9	„ 1 10	0·3707	
1174	Rairangpur	„ 12	22 15 20	86 11 0	29 45	„ 0 58	0·3720	
1175	Kasmi	„ 13	21 50 0	86 15 10	28 14	„ 0 18	0·3789	
1176	Baripáda	„ 14	21 55 50	86 43 0	29 5	„ 0 33	0·3737	
1177	Dantan	39/88 7	21 56 10	87 16 40	29 10	„ 0 53	0·3726	
1178	Contai	„ 8	21 46 40	87 44 30	28 30	„ 0 44	0·3759	
1179	Balikuda	39/89 8	20 8 30	86 16 10	25 9	„ 0 28	0·3809	
1180	Chandbali	„ 9	20 46 10	86 43 40	26 42	„ 0 19	0·3797	
1181	Amarpur	39/93 11	23 32 0	91 39 30	32 7	„ 1 2	0·3727	
1182	Singurajabari	„ 12	24 8 0	91 53 50	33 17	„ 1 7	0·3709	
1183	Silghata	39/93 7	22 12 20	92 8 30	29 38	„ 0 57	0·3767	
1184	Golabari	39/94 13	23 5 0	91 58 50	31 17	„ 1 3	0·3743	
1185	Nandgaon	39/95 12	27 42 50	77 23 10	39 22	„ 2 8	0·3447	
1186	Palwal	„ 13	28 8 50	77 19 50	40 7	„ 2 13	0·3425	
1187	Tamu	39/94 7	24 12 50	94 19 0	33 34	„ 0 58	0·3712	
1188	Lénácot	„ 8	23 54 30	93 47 50	32 50	„ 1 7	0·3724	
1189	Turizán	„ 9	23 35 30	93 41 30	32 15	„ 1 6	0·3732	
1190	Fort White	„ 10	23 14 50	93 46 30	31 35	„ 1 16	0·3740	
1191	Tao	39/94 7	22 45 50	93 11 20	30 43	„ 0 56	0·3759	
1192	Háka	„ 8	22 38 30	93 37 20	30 32	„ 0 59	0·3756	
1193	Kán	„ 9	22 24 40	94 6 20	30 7	„ 0 53	0·3777	
1194	Sihaung	„ 10	22 51 0	94 3 20	31 4	„ 0 50	0·3767	
1195	Moulmein	39/96 1	16 29 40	97 37 30	17 45	„ 0 36	0·3926	
1196	Thatôn	„ 2	16 55 10	97 20 20	18 36	„ 0 36	0·3918	
1197	Kyaikto	39/97 1	17 18 40	97 1 0	19 26	„ 0 37	0·3923	
1198	Thaungbyin	39/96 10	19 55 20	96 31 10	25 4	„ 0 42	0·3851	
1199	Thitkyeit	„ 11	19 37 50	96 40 30	24 34	„ 0 40	0·3860	
1200	Pinlaung	„ 12	20 7 50	96 46 50	25 29	„ 0 40	0·3845	
1201	Loiput	39/98 8	20 17 30	97 18 40	25 51	„ 0 45	0·3845	
1202	Mawkmai	„ 9	20 13 10	97 43 30	25 45	„ 0 44	0·3848	
1203	Ta-Sup-Teng	„ 10	19 51 20	97 45 10	25 0	„ 0 40	0·3857	
1204	Namon	„ 11	19 21 40	97 30 50	23 58	„ 0 43	0·3872	
1205	Loikaw	„ 12	19 40 20	97 13 10	24 36	„ 0 43	0·3863	
1206	Kreuko	„ 13	19 15 10	97 2 30	23 48	„ 0 42	0·3867	
1207	Pazaung	39/98 2	18 52 10	97 18 40	22 56	„ 0 47	0·3882	
1208	Salween	„ 3	18 27 0	97 21 40	21 57	„ 0 39	0·3893	
1209	Papun	„ 4	18 3 20	97 27 20	21 16	„ 0 43	0·3886	
1210	Maipali	„ 5	17 30 50	97 38 40	20 1	„ 0 36	0·3908	
1211	Hlaingbwe	„ 6	17 7 0	97 49 10	19 7	„ 0 40	0·3914	
1212	Mergui	39/99 1	12 26 50	98 38 50	8 35	„ 0 32	0·3965	
1213	Palaw	„ 2	12 58 0	98 44 20	9 52	„ 0 31	0·3967	
1214	Shintabi	39/98 1	14 29 10	98 10 0	13 17	„ 0 37	0·3955	
			Old Stations re-observed.					
46	Ruk	38/75 3	27 48 20	68 38 20	39 21	E 2 7	0·3354	
92	Kundian	38/74 4	32 27 30	71 28 20	47 31	„ 3 26	0·3107	
98	Amritsar	38/74 7	31 38 10	74 51 30	45 33	„ 2 55	0·3238	
105	Sachin	38/73 9	21 4 40	72 52 40	27 13	„ 0 28	0·3654	
130	Ajmer	38/75 3	26 27 30	74 38 30	37 12	„ 1 57	0·3462	
171	Kirkee	38/74 2	18 33 30	73 50 0	22 21	„ 0 9	0·3668	
177	Wádi Junction	38/74 1	17 3 0	77 0 0	18 44	„ 0 13	0·3758	
186	Atkonam	38/77 5	13 5 10	79 40 20	10 4	W 0 27	0·3835	
199	Cannanore	38/74 5	11 52 30	75 22 0	7 32	„ 0 27	0·3819	
216	Miraj	38/74 1	16 49 10	74 38 10	19 4	„ 0 4	0·3771	
232	Delhi	38/75 2	28 40 20	77 14 20	40 57	E 2 2	0·3405	
335	Trichinopoly	38/77 2	10 47 30	78 40 40	4 51	W 1 3	0·3812	
355	Bellary	38/76 2	15 8 50	76 55 30	14 31	„ 0 23	0·3766	
373	Jálna	38/75 4	19 51 50	75 53 0	24 52	E 0 47	0·3704	
376	Nander	38/77 1	19 9 30	77 18 10	23 56	„ 0 12	0·3715	
384	Bezwada	38/80 1	16 31 0	80 36 50	17 34	W 0 18	0·3814	
481	Allahabad	38/81 7	25 27 30	81 49 20	35 25	E 1 26	0·3582	
489	Monghyr	38/86 8	25 23 10	86 27 50	35 25	„ 1 21	0·3629	
494	Sainthia	38/87 3	23 56 50	87 41 20	32 54	„ 1 8	0·3680	
500	Sini	38/85 1	22 47 0	85 56 50	30 21	„ 1 3	0·3730	

H, is derived from Mean M°. throughout.

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season 1907-08—concld.

Serial No.	Name of station.	Survey No.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ° ′	Declination. ° ′	Horizontal Force. C.G.S.	Remarks.
522	Bhatni	3	26 23 0	83 55 40	37 12	E 1 38	0·3560	H. is derived from Mean M.° throughout.
545	Bina	4	24 10 50	78 11 0	33 13	„ 1 9	0·3602	
557	Indore	1	22 42 10	75 52 40	30 26	„ 0 57	0·3650	
573	Cawnpore	4	26 27 0	80 21 0	37 21	„ 1 50	0·3534	
579	Sutna	1	24 34 20	80 50 0	34 13	„ 1 27	0·3598	
692	Balasore	4	21 30 30	86 54 40	28 8	„ 0 46	0·3759	
699	Berhampore	1	19 18 10	84 48 40	23 32	„ 0 24	0·3804	
710	Cumbum	6	15 35 50	79 6 40	15 46	„ 0 3	0·3777	
761	Khairi	3	22 55 20	81 52 50	30 39	„ 1 3	0·3665	
765	Raipur	5	21 15 50	81 38 20	27 51	„ 0 43	0·3709	
775	Kamptee	8	21 12 30	79 12 40	27 34	„ 0 51	0·3682	
1026	Rangamati	3	22 38 10	92 11 50	30 23	„ 1 0	0·3760	

Repeat Stations.

Serial No.	Name of Station.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ° ′	Declination. ° ′	Horizontal Force. C.G.S.	Remarks.
I	Udaipur	24 35 33	73 41 57	33 49	E 1 24	0·3530	H. is derived from Mean M.° throughout.
II	Karachi	24 49 50	67 2 2	34 14	„ 1 40	0·3457	
III	Quetta	30 11 52	67 0 20	43 7	„ 2 58	0·3232	
IV	Bahâwalpur	29 23 27	71 40 37	42 9	„ 2 51	0·3318	
V	Râwalpindi	33 35 16	73 3 6	48 18	„ 3 42	0·3122	
VI	Bharatpur	27 13 27	77 29 28	38 42	„ 1 59	0·3458	
VII	Bangalore	12 59 35	77 35 58	9 48	W 0 37	0·3811	
VIII	Dhârwâr	15 27 26	74 59 35	15 23	„ 0 13	0·3761	
IX	Porbandar	21 38 20	69 37 6	28 45	E 1 13	0·3600	
X	Fyzabad	26 47 27	82 7 40	37 54	„ 1 48	0·3529	
XI	Sambalpur	21 28 3	83 58 24	27 52	„ 0 49	0·3725	
XII	Waltair	17 42 57	83 19 1	21 12	„ 0 15	0·3785	
XIII	Darjeeling	26 59 49	88 16 39	38 18	„ 1 36	0·3570	
XIV	Gaya	24 46 30	84 58 54	34 16	„ 1 9	0·3659	
XV	Secunderabad	17 27 11	78 29 16	20 11	„ 0 18	0·3792	
XVI	Bhusâval	21 2 46	75 47 18	26 59	„ 0 50	0·3680	
XVII	Jubbulpore	23 8 57	79 56 44	31 2	„ 1 3	0·3643	
XVIII	Tavoy	14 4 50	98 12 30	12 19	„ 0 31	0·3957	
XIX	Lashio	22 56 47	97 44 40	31 16	„ 0 47	0·3762	
XX	Akyab	20 7 53	92 53 18	25 29	„ 0 45	0·3838	
XXI	Silchar or Cachar	24 49 43	92 47 21	34 43	„ 1 13	0·3692	
XXII	Dibrugarh	27 29 24	94 55 40	39 30	„ 1 19	0·3587	

NOTE.—The above values of Dip, Declination and Horizontal Force are uncorrected for secular change, diurnal variation, instrumental differences, etc., and are to be considered preliminary values only.

Where blanks occur, values have already been found during previous field seasons, or the observations have not been completed.

The Survey numbers refer to the published chart: thus No. $\frac{26}{3}$ 3 denotes No. 3 station, the spherical co-ordinates of whose centre are 26° North Latitude and 76° East Longitude.

All Longitudes are referable to that of Madras Observatory taken at the value 80° 14′ 47″ East from Greenwich.

TOPOGRAPHICAL SURVEYS.

CENTRAL AND UNITED PROVINCES AND CENTRAL INDIA STATES.

No. 1 Party (*vide* Index Map No. 1).

117. The party was employed in completing to margin standard sheets of which the Central Provinces portion only had been surveyed, and the contouring of which required revision.

Personnel.

Imperial Officers:

Lieutenant M. N. MacLeod, R.E., in charge up to 2nd April 1908.
Lieutenant K. W. Pye, R.E., in charge from 3rd April 1908.

Provincial Officers:

Messrs. F. S. Bell, F. P. Walsh, W. Skilling, C. Litchfield, H. W. Biggie, B. M. Berrill, and R. E. Saubolle, Babu Munshi Lal.

Subordinate establishment:

46 Surveyors, etc.

128. Field work commenced on the 1st of November and continued till the middle of May, by which date the programme was completed with the exception of a small area in one sheet.

129. The outturn of the surveyors has continued to improve with a few exceptions, and that of the whole party has increased notwithstanding the reduction in numbers. The number 46 shown in the margin was the strength of the surveyors, etc., on taking the field. Of these, one surveyor died, two were discharged for irregular conduct, one retired voluntarily, and one was discharged as unlikely to become efficient.

130. The greater part of the area surveyed consisted of revision survey in the Central and United Provinces. The remainder, entirely new survey, lay in the Central India States. The country surveyed was of varying description, consisting of steep jungle-clad hills from 150 to 300 feet in height, generally flat-topped, and lying for the most part in the Saugor and Hatta *tahsils*. To the north-west of the Sunár river in the Damoh district there was flat or gently sloping ground covered with jungle, while in the Khurai *tahsil* of the Saugor district there were extensive flat grass lands and cultivated plains.

Four large rivers, the Bína, Biás, Sunár, and Birma, flow through the work.

131. The outturn of the season and cost-rates per square mile are as follows:—

	Square miles.	R
Re-survey on 1-inch scale of Central India States	351	12·4
Re-survey on 2-inch scale of Central India States	177	25·4
Revision survey on 2-inch scale	2,619	17·3
Fair mapping	3,264	5·0

The area surveyed lay in sheets 54 $\frac{L}{7, 8, 12, 16}$, 54 $\frac{P}{4, 7, 8, 12, 16}$, 55 $\frac{I}{5, 6,}$ and 55 $\frac{M}{9, 13.}$

132. The total cost of the party for the year under report was R1,01,348.

133. Triangulation on a large scale was undertaken for the first time for some years. The country triangulated was for the most part thickly wooded, and much clearing was found necessary, several sorts of double trestles or stands of kinds to raise the theodolite above the jungle were tried with varying success. The wooded nature of the country made the work slow and restricted the outturn, but an area of 2,274 square miles was completed at a cost of R9·9 per square mile including computation.

134. The boundaries of 86 villages with a total length of 433 miles were traversed for the Local Government, at a cost of R4,105, and 203 miles of traversing for topographical requirements were carried out, at a cost of R4,107 including computation.

135. The average outturn per man per month in each class of work was as follows:—

New survey 1 inch=1 mile—16·6 square miles, with 15 fixings and 3 heights per square mile.

New survey 2 inch=1 mile—7·4 square miles, with 27 fixings and 7 height per square mile.

Revision 2 inch=1 mile—17·9 square miles, with 12 fixings and 5 heights per square mile.

Triangulation—114 square miles.

Traversing topographical—22·6 linear miles with 4 stations per mile.

Traversing cadastral—23·7 linear miles with 7 stations per mile.

136. The attitude of the villagers particularly in the Saugor district was far from friendly, and much difficulty was often experienced in obtaining assistance and supplies. In the Panna State, however, the officials showed great courtesy and willingness to help all round, and no difficulties were consequently experienced.

137. The mapping was not quite completed during the recess, but sheets $54\frac{L}{7,\ 8,\ 12,\ 16}$, $\frac{P}{4,\ 8,\ 12,}$ $55\frac{I}{5,\ 6,}$ and $55\frac{M}{13,}$ will be sent in for publication early in the field season, and it is hoped to submit sheets $54\frac{P}{7,\ 16,}$ for publication early in 1909. Triangulation charts await further triangulation before completion. The computations of triangulation required for next season's work were completed, and the remainder will be completed during the field season.

138. The party was inspected by the Deputy Surveyor General during the field season, and was under his direct supervision for a portion of the recess.

139. Next season supplementary triangulation will be carried out in sheets—

$$64\ \frac{A}{4,\ 8,\ 11,\ 12,\ 15,\ 16}\ ,\ 55\ \frac{M}{4,\ 6,\ 7,\ 8}\ ,\ 55\ \frac{I}{14,\ 15,\ 16}\ ,$$

and re-survey and revision in sheets—$64\ \frac{A}{1,\ 5,\ 9,\ 10,\ 13,\ 14}$; $55\ \frac{M}{1,\ 2,\ 3,\ 5,}$ and part of $55\ \frac{M}{9}$, $55\ \frac{I}{10}$, $55\ \frac{N}{5}$.

BERAR.

No. 2 Party (*vide* Index Map No. 1).

140. The party was constituted as in previous years as an instructional one and was employed on the continuation of the topographical survey of Berar on the scales of 1 and 2 inches = 1 mile.

Personnel.

Imperial Officers:

Captain H. Wood, R.E., in charge, Lieutenant R. Foster, I.A., from 3rd October to 3rd December 1907, Lieutenant J. A. Field, R.E., from 12th May 1908.

Provincial Officers:

Messrs. A. Ewing, C. J. Veale, and E. A. Meyer and 15 Probationers.

Subordinate Establishment:

7 Soldier Surveyors, 3 Surveyors, 2 Clerks, 1 Computer, 1 Hospital Assistant.

141. Field work commenced on the 17th October 1907. The area triangulated in advance of the detail survey covered 2,180 square miles and comprised the whole of sheets $55\frac{H}{1,\ 2,\ 5,\ 6}$ and $55\frac{L}{3,\ 4,\ 7,\ 8}$. The country required careful reconnaissance as most of that in sheet 55H was very flat with no commanding features, while that in sheet 55L was in many places heavily wooded. The average number of square miles to each point trigonometrically fixed is 3·9.

142. The detail survey of 1,316 square miles was carried out. Sheets $55\ \frac{H}{4,\ 7,\ 8,\ 12,\ 16}$ were completed and sheet $55\frac{H}{3}$ was partially surveyed. Rather more than half the area was on the scale of 2 inches = 1 mile, the remainder being on the scale of 1 inch = 1 mile. The average monthly outturn per man per month was 7·8 and 20·2 square miles of detail survey on the two scales respectively.

143. The country surveyed on the 2-inch scale was very difficult for untrained men. It consisted of very broken hills covered with forest sufficiently

dense to prevent the view of anything more than a few chains distant. That surveyed on the 1-inch scale was on the other hand very easy, being undulating country with very little detail and plenty of easily distinguishable natural features.

144. The boundaries of all A and B class forest reserves which fell in the area of detail survey were traversed by the plane-table, and plotted on the scale of 4-inches to the mile. The total length of such traverses was 286 miles. Field work closed on the 2nd May 1908.

145. The total cost of the party for the season under report was Rs95,347.

146. The fair mapping of all the sheets completely surveyed (sheets $55\frac{H}{4, 7, 8, 12, 16}$) was finished during the recess, as also the computation of the triangulation, and the fair maps will shortly be submitted for publication.

147. During the month of January Mr. Kenny while engaged on triangulation work, had the misfortune to be involved in a *fracas* with some villagers, and was compelled to shoot one in self-defence. Mr. Kenny, it is, however, satisfactory to mention, was subsequently exonerated from all blame and commended for his forbearance, while the punishment subsequently inflicted on his assailants will, it is hoped, prevent such attacks in future. With this exception, however, the relations with the villagers were good in the area surveyed, and the authorities assisted in every way.

148. The party was inspected by the Deputy Surveyor General both during the field season and in recess.

149. Next season it is proposed to turn the party into an ordinary topographical one, and the survey of sheets $55\frac{H}{1, 2, 3, 5, 6}$ and $55\frac{L}{2, 3}$ is to be completed on the 1-inch scale, and sheets $55\frac{K}{11, 12, 15, 16}$ are to be triangulated in advance.

BOMBAY PRESIDENCY.

No. 17 Party (*vide* Index Map No. 1).

150. This party was divided into three camps, under Messrs. Norman, Wilson, and Anderson, and the three detachments left Poona for the field about 12th November 1907 and returned to recess quarters on 1st June 1908, a somewhat longer field season than usual; this being necessary to complete the survey of the country known as Akhráni, a mountainous and desolate tract of the Sátpudas, notoriously malarious, and which it is inadvisable to enter before February.

Personnel.

Imperial Officer:

Mr. B. G. Gilbert-Cooper, in charge from 1st June 1908 to 29th July 1908.

Provincial Officers:

Mr. S. F. Norman (Senior), in charge up to 31st May 1908, and from 30th July 1908, Messrs. J. H. Wilson, P. R. Anderson, F. B. Kitchen, and C. O. Picard, Babus A. K. Mitra, and P. C. Mitra.

Subordinate Establishment.

30 Surveyors, 2 Clerks, and 1 Hospital Assistant.

151. The operations of the party comprised—

(1) Revision, on scale 2 inches = 1 mile, of sheets $46\frac{O}{4, 8, 12, 10,}$ amounting to 1,108 square miles.

(2) The re-survey, on scale 2 inches = 1 mile, of sheets $46\frac{K}{1, 5, 10, 14,}$ and parts of $46\frac{K}{2, 6}$ amounting to 1,250 square miles.

(3) Forest boundary surveys on the scale 4 inches = 1 mile amounting to 423 linear miles.

(4) Supplementary triangulation over sheets $46\frac{O}{9, 10, 11, 13, 14, 15}$ and $46\frac{P}{1, 2, 5, 6, 9, 10, 13, 14}$ for 1-inch scale detail surveys, amounting to 3,375 square miles.

152. The following table shows in detail the outturn with cost-rates for the year under report, and for purposes of comparison those of the preceding year are also given :—

Description of Survey.	Outturn sq. miles.		Cost-rates per sq. mile.	
	1906-07.	1907-08.	1906-07.	1907-08.
Triangulation 1″=1 mile	2,155	3,375	R5·5	R3·0
Topography revision survey 2″=1 mile	2,292	1,108	15·6	18·0
Topography re-survey 2″=1 mile	348	1,250	31·6	32·7
Skeleton forest boundary survey 4″=1 mile (linear miles).	140	423	4·7	7·2

The area triangulated is largely in excess of last season's owing to the fact that it was done for 1-inch scale surveys while that for the previous season was done for work on the 2-inch scale, and for this reason no comparison can be made of cost-rates. The area of revision survey completed this season is less than half of the area done last season, and the cost-rate is slightly in excess. But this is more apparent than real, as last year's area contained 364 square miles of forest that had been previously surveyed on scale 4 inches = 1 mile, and being of recent survey it required but little revision. Had this area been excluded the cost-rate for last year would have amounted to R19·5 per square mile. This season's cost-rate therefore bears favourable comparison with that of the previous year. The area of re-survey is largely in excess of last year's and the cost-rates are almost identical, and this is satisfactory considering the nature of the country which was the most trying and difficult that the party has yet had to contend with.

153. The total cost of the party for year under report amounts to R80,556.

154. The area under re-survey embraced 554 square miles of reserved forest (which had not been previously surveyed on any larger scale) and included in—

	Square miles.
Taloda (including Akhráni)	384
Sháháda	57
Shirpur	113

while the forest area under revision was insignificant, amounting to only 0·87 square miles.

The skeleton forest boundary survey was as follows :—

	Linear miles.
Taloda (including Akhráni)	327·8
Sháháda	58·7
Shirpur	36·0

155. The detail surveys were tested in the field by 714 linear miles of chain *partal*, in addition to *in situ* examinations, which had to be largely resorted to over the area under re-survey, owing to the rugged nature of the country. The detail survey on 2-inch scale was tested by 1 linear mile of check line to 3·3 square miles surveyed. The averages for the revision and re-survey work out as follows :—

	Square miles, daily.	Square miles, monthly.	No of fixings per square mile.
Revision	0·69	15·2	17
Re-survey	0·47	10·3	31

156. During the recess the mapping has made good progress, and every effort has been made to reduce the arrears of Forest mapping pertaining to season 1905-06. It is hoped that before the close of this recess 23 sections on the scale 4 inches = 1 mile, pertaining to the Sátára district will be submitted for publication, leaving 22 sections in all to be completed and published next year.

In addition, the drawing of the 10 standard sheets on a scale of 2 inches = 1 mile, is well in hand, and sheets 46 $\frac{K}{10}$, 46 $\frac{O}{4, 8, 12, 16}$, will be submitted for publication early in November. The remaining sheets 46 $\frac{K}{1, 2, 5, 6, 14}$ will, it is hoped, be sent in during the field season.

157. The arrears of computations have been cleared off, and the computation of the season's triangulation will be fully completed before the party leaves recess quarters.

158. The health of the party in the plains was excellent, but in other places there was a good deal of malarial fever.

159. The Deputy Surveyor General inspected the party on several occasions during the months of September and October 1908.

160 The programme for 1908-09 comprises :—

Revision survey on scale 1 inch = 1 mile of sheets 46 $\frac{K}{9, 13}$, and portions of sheets 46 $\frac{O}{1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 14, 15}$, amounting to about 3,190 square miles

Re-survey, on scale 2 inches = 1 mile, of the forest areas in sheet 46 $\frac{O}{2, 3, 7, 11, 15}$, amounting to about 675 square miles.

Boundary survey on scale 4 inches = 1 mile, of such forests as falls within sheets 46 $\frac{O}{2, 3, 7, 11, 15}$, and supplementary triangulation of sheets 46 $\frac{P}{3, 4, 7, 8, 11, 12, 15, 16}$, amounting to about 2,230 square miles.

BURMA.

No. 3 Party (*vide* Index Map No. 2).

161. The recess office at Bangalore closed on the 12th November 1907 and re-opened there again on the 26th June 1908, which gave the party another long field season. The original programme comprised the completion of degree sheet 84 K partly on the 1-inch and partly on the 2-inch scales but owing to several surveyors being absent on sick leave and two on deputation the party was only able to survey nine out of the twelve standard sheets allotted to it.

Personnel.

Imperial Officer :

Captain C. P. Gunter, R.E., in charge.

Provincial officers :

Messrs. W. M. Gorman, J. O'B. Donaghey, S. F. Norman (Junior), E. Claudius, and H. D. Stotesbury.

Subordinate Establishment :

23 Surveyors, 2 Traversers, and 4 Draftsmen.

162. The outturn and cost-rates of the party for the season under report were as follows :—

Nature of Survey.	Outturn, sq. miles.	Cost-rates per square mile.	Remarks.
		R	
Triangulation	1,070	22·3	
Traversing	188 (*a*)	56·0 (*a*)	(*a*) Linear miles.
Detail survey, 1-inch scale . . .	414	24·1	
" " supplementary, 1-inch scale	1,688	24·8	Including mapping.
" " 2-inch scale . . .	299	88·0	
TOTAL DETAIL SURVEY . . .	2,401		

The average monthly outturn of a surveyor was 30 square miles for 1-inch survey, 25 for 1-inch supplementary survey, and 7 for 2-inch survey. Much of the cadastral survey on which the supplementary survey was based consisted merely of *kwin* boundaries without any detail, so that the survey was really a new one and the country was much more difficult than that in which the original survey was carried out; this accounts for the results not being better. An area

of 299 square miles of forest reserves was surveyed on the 2-inch scale and maps containing forest area will be published on that scale for the use of the Forest department.

The total cost of the party was at R1,13,490 for the year ending 30th September 1908.

163. At the request of the Government of Eastern Bengal and Assam, Surveyor Pertab Singh was deputed to accompany the Superintendent of the Lushai Hills on an expedition sent out for the purpose of defining the limits of the Lushai Hills, the Chin Hills, and the Arakan Hill tracts; he completed the survey of 1,194 square miles of hitherto unmapped country on the $\frac{1}{4}$-inch scale. Mr. Morton from No. 26 Party joined the expedition at a later date for the purpose of extending the triangulation.

164. The health of the party was good, although several members of it suffered from fever contracted in the previous season in the Salween valley. Heavy rains occurred during the last few weeks of the field season and retarded the work.

165. The area under survey was of varied character. In the south-east corner the country on both banks of the Irrawaddy consisted partly of open cultivated plains and partly of low bare ridges and undulating ground, cut up by innumerable streams; here the interesting ruins of old Pagan and the oil fields of Yenangyat are to be found. To the west and north-west the country rose gradually through the lower spurs and eastern slopes of the Chin Hills, on which a number of forest reserves are situated, up to the main range where an altitude of 8,000 feet was reached. The well known and prominent peak Mount Victoria, over 10,000 feet in height, lay a few miles to the west of the limits of the survey. The hills are thickly wooded and the forest reserves are much cut up by watercourses which rendered their survey, on the 2-inch scale, a very difficult and tedious operation.

166. The area surveyed was mapped on the $1\frac{1}{2}$-inch scale for reduction to 1-inch standard sheets of which the following eight were completed and submitted for publication :— 84 $\frac{K}{3, 7, 8, 10, 11, 12, 15, 16}$ and sheet 84 $\frac{K}{4}$ will be fair drawn shortly.

167. The draftsmen of the party have now mastered the new system of mapping and the improvement in the quantity and quality of their work is marked.

168. The party was inspected in the field and in recess by the Superintendent in charge Burma Surveys.

169. Triangulation for next season's topography was carried out over 1,070 square miles. In the flat country to the east of the Chindwin river which covered about 700 square miles, it was also found necessary to supplement the triangulation by traversing, by which the heights of many prominent points were determined. As the party will be transferred to the Madras Presidency in season 1909-10, the triangulators will be attached to the Coorg detachment, and will carry out advance triangulation for the party in Coorg, Malabar, and South Canara. The programme of detail survey in Burma for the ensuing season consists of the 1-inch survey and supplementary survey of 3,032 square miles in sheets 84 J and 84 K chiefly in the Chindwin valley.

UPPER BURMA.

No. 10 PARTY (*vide* INDEX MAP NO. 2).

170. The party left its recess quarters at Bangalore on the 6th of November 1907 and returned there on the 24th of June 1908. In future the party will recess at Maymyo in Burma, and the loss of time spent on the journeys to and from Burma to Bangalore will be avoided.

Personnel.

Imperial Officer :

Captain A. A. McHarg, R.E., in charge.

Provincial Officers :

Messrs. P. J. Barrington, M. J. Sheehan, W. G. Jarbo, and E. M. Kenny, Munshis Asmat Ullah Khan and Abdul Rahim, K. S.

Subordinate Establishment :

24 Surveyors, 2 Traversers, 1 Computer, 1 Typer, 2 Clerks, 1 Hospital Assistant.

171. The outturn and cost-rates of the party were as follows :—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		R	
Triangulation	3,337	6·49	
Traversing	248 (a)	31·38(a)	(a) Linear miles.
Detail survey, 1-inch scale . .	1,707	34·17	
Supplementary survey „ „ . .	887	19·90	The cost-rates include the cost of fair mapping.
Revision survey . „ „ . .	89	19·81	
Survey, 2-inch scale	465	50·40	
„ 4- „ „	4	56·00	
TOTAL DETAIL SURVEY .	3,152		

The average monthly outturn of a surveyor was 32·19 square miles for 1-inch, 57·12 for supplementary, and 11·16 for 2-inch surveys. Part of the supplementary survey consisted of area previously cadastrally surveyed on the 16-inch scale and part of forest reserves previously surveyed on the 4-inch scale; in the case of the latter, the old detail was generally accepted but the work had to be re-contoured. The cost-rate per square mile of the former class of supplementary survey was R23·5 for an area of 497 square miles, and of the latter R15·4 for an area of 390 square miles. For the most part, the cost-rates of this party compare very favourably with those of last year. The total cost of the party for the year ending 30th September 1908 was R1,33,045.

172. The detail survey was on the scale of 1 inch=1 mile with contours at 50 feet vertical interval, and 2 inches=1 mile for forest reserves, of which an area of 465 square miles was surveyed; special maps of this area on the scale of survey will be published for the use of the Forest department. Owing to sickness among the surveyors the party was unable, notwithstanding its long field season, to quite complete its programme, which was an ambitious one considering the strength of the party. The small area remaining over will be surveyed early next season, and will be mapped in the Burma Drawing office. The country under survey was of a very varied description. In Katha, Shwebo, and Upper Chindwin districts, falling principally in degree sheet 84 M, the country consisted partly of cultivated plains and partly of comparatively low hill ranges covered with jungle. In the north of the Ruby Mines district the area lay in the valleys of the Irrawaddy and Shweli rivers, and the country was generally undulating or flat with marshes and plains covered with a dense growth of *kine* grass. The survey of sheets 93 $\frac{E}{4, 8}$ was taken up at the instance of the Geological Survey department on account of the important lead and silver mines occurring in them. These mines in former times had been worked by the Chinese who abandoned them after extracting all the silver they could find; a company has recently been formed with the immediate object of extracting the lead from the slag which lies in mounds near the old workings. A mineral line has been built connecting the mines with the Lashio branch of the Burma railways. These sheets comprise a portion of the Northern Shan States consisting of high steep jungle-covered hills inhabited chiefly by Kachins, Lihsaws, and Palaungs. The climate was trying and the health of the party was not good except in the Shan States. Three *khalásis* died of cholera on the voyage between Calcutta and Rangoon, on the way to the field.

173. The following eight sheets have been surveyed and drawn in the party on the 1½-inch scale and will be submitted shortly for publication as 1-inch standard sheets, *viz.*—84 $\frac{M}{2, 6, 10, 14}$, 93 $\frac{A}{1, 5,}$, and 93 $\frac{E}{4, 8}$. The remaining 4 sheets, *viz.*, 84 $\frac{M}{1, 5, 9, 13}$ will be completed in the Burma Drawing office and also sheet 84 $\frac{I}{15}$ of which only a portion, consisting entirely of reserve forest, has been surveyed on the 2-inch scale and will be drawn for publication on that scale. The failure to complete the mapping was due chiefly to the short recess season which consisted of a little over four months. The computations of the traversing and triangulation have been completed, and good progress has been made in the preparation

of triangulation charts. The party was inspected in the field and in recess by the Superintendent in charge Burma Surveys.

174. The programme for 1908-09 consists of the completion of the detail survey on the 1-inch scale in degree sheets 84 M and 93 A. Forests occurring in the programme which have already been surveyed on the 4-inch scale will be supplemented and contoured on the 1-inch scale and new forests will be done on the 2-inch scale. The Mosit reserve in the Bhamo district which lies outside the programme will be surveyed at the expense of the Forest department. Triangulation will be extended into degree sheet 92 H.

SHAN STATES, BURMA.

NO. 11 PARTY (*vide* INDEX MAP NO. 2).

175. The recess quarters of the party, which were at Bangalore during the previous year, were transferred to Maymyo, which is on the whole, the most convenient recess quarters for parties working in Burma. The newly erected head-quarter offices of the Burma Police have been placed at the disposal of the department and Nos. 10 and 11 Parties will occupy them in future. The journey from Bangalore to the field occupied seven to eight weeks. Field work was not commenced until the middle of December and the field season lasted for about four and a half months.

Personnel.

Imperial Officers:

Captain R. H. Phillimore, R.E., in charge.
Lieutenant L. G. Crosthwait, I.A.

Provincial Officers:

Messrs. S. S. M. Fielding, V. W. Morton, T. P. Dewar, and A. A. Graham.

Subordinate Establishment:

30 Surveyors, etc.

176. The outturn and cost-rates of the party were as follows:—

Nature of survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	REMARKS.
		ℝ	
Triangulation	3,800	8·9	Inclusive of mapping.
Detail survey, 1½-inch scale . . .	2,303	44·9	

The average daily outturn of a surveyor was 1·19 square miles. As it was too late to change the scale in this party the survey was carried out on the 1½-inch scale as in the previous year with contours at 50 feet vertical interval. The outturn on the 1½-inch scale has proved to be only 10% less than on the 1-inch in similar country. The quality of the work, triangulation, topography, and mapping is good and the surveyors are rapidly adapting themselves to the new conditions.

The total cost of the party for the year under report amounted to ℝ1,41,591 including ℝ2,198 on account of the training school at Bangalore.

177. The health of the party was fairly good. The climate in the low country along the Siamese frontier and in the Me-kong valley, the mean level of which was between 1,500 and 2,000 feet above sea-level, was trying. Smoke and haze interfered considerably with the work during February and March. Heavy rain was met with during the return journey to Maymyo which was a trying one. There were the usual cases of malarial fever; two surveyors died at their homes during recess and two menials during the field season.

178. The area surveyed was situated in the Kēng-Tung State on the borders of Siam and of the *Province du haut Me-kong* in French Indo-China. In the north the hills rose to over 6,000 feet and were covered with open pine forest. Further south near the Siamese frontier the hills were not so high or steep as in the north and open grassy plains were met with. The country surveyed was well populated by many different tribes. Communications were good, as in this corner of the Shan States several main trade routes meet. Steamers have ascended the Me-kong as far as Tang-aw (latitude 21°·40'), but the regular service stops at Ban Hwé Sai, the head-quarters of the *Province du haut Me-kong*

sixty miles lower down. Kêng Tung is the great mart in this part of the world for all commodities, and there is a flourishing trade in pickled tea, lead, salt, cotton, lac, rubber, opium, piece goods, and pottery between China, Siam, and French Indo-China.

179. Most friendly relations were maintained with the people of the country throughout the area under survey, and labour and supplies were plentiful and readily obtained.

180. The area surveyed was mapped in twelve sheets, *viz.*, 93 $\frac{P}{11, 13, 14, 15}$, 102 $\frac{C}{4, 8, 12}$, and 102 $\frac{D}{1, 2, 3, 5, 9}$; these will all be submitted for publication before the end of the year. The maps were drawn on the 1½-inch scale for reduction to 1-inch. The triangulation carried out in the field was computed during the recess, and the work has proved satisfactory.

181. The programme for 1908-09 consists of the continuation of the survey on the 1-inch scale of the Southern Shan States in sheets 93 N and O and in 102 C and G, an area of about 3,250 square miles, and the triangulation of about 800 square miles in 93 J, N and O.

MADRAS.

No. 19 Party (*vide* Index Map No. 3).

182. The party left its recess quarters at Bangalore in November 1907 and returned there in May 1908, giving a full field season of six months.

Personnel.

Imperial Officers:
Captain F. F. Hunter, I.A., in charge.
Lieutenant C. G. Lewis, R.E., from 1st June 1908.

Provincial Officers:
Messrs. R. Waller-Senior, J. Smith, W. F. E. Adams, and E. J. Biggie, Babus Mahadeva Mudaliar and Balaji Dhondiba.

Subordinate Establishment:
49S urveyors, 2 Writers, 1 Record-keeper, and 1 Hospital Assistant.

183. The outturn and cost-rates of the party are given in the following table:—

Description of Survey.	Outturn, sq. miles.	Cost-rates, per sq. mile.	Remarks.
		R	
Triangulation	5,531	3·5	
Traversing	267(*a*)	46·8 (*a*)	(*a*) Linear miles.
Detail survey, 4-inch scale . . .	39	326·0	
„ „ 2 „ „ . . .	1,441	52·8	
Revision survey, 2-inch scale . .	71	5·3	
Detail survey, 1- „ „ . .	303	8·5	
Revision „ 1- „ „ . .	302	6·8	
Total Detail Survey .	2,156		

The average monthly outturn of a surveyor was 2·04 square miles for 4-inch, 8·17 for 2-inch, and 20·55 for 1-inch survey.

184. The survey consisted of the completion of the 4-inch survey of settled forest reserves in the Ganjám district, and of a topographical survey on the 1-inch and 2-inch scales in degree sheets 49 H and 58 A. The revision was that of the Mysore survey originally done between 1874 and 1886; in order to test the work the revision was done more carefully and thoroughly than will be

necessary in the greater part of the State. The work was found on the whole very good, except in the more thickly-wooded portions, and its revision will be easy and comparatively inexpensive. Owing to the difficult nature of the country the cost-rate of the 2-inch survey is high. That of 4-inch forest survey is very high, but is due to the small area dealt with and to the fact of the forest being situated in a remote part of the country (Ganjám), to and from which the transit charges were unusually heavy. The total cost of the party for the year ending 30th September 1908 was Rı,22,816.

185. Except on the Malabar coast the health of the party was not good. There was much fever among the men working in Ganjám and in the Wynaad, not only during the field season, but after the return of the party to recess quarters. One surveyor and two *khalásis* died during the year. The climate on the coast was pleasant enough though hot; both there and in the Wynaad, early rains in April and May interfered considerably with the work.

186. The country topographically surveyed was situated in the Malabar and Nilgiri districts and in the Mysore State. It consists of a wide level strip along the coast, of a portion of the Wynaad (a plateau 3,000 feet above sea-level which forms a continuation of the Mysore plateau), and part of the high range of the Western *ghats*. The coastal tracts, although containing extensive rice plains and backwaters, present the appearance when viewed from above, of a sea of cocoa-nut palms. The Wynaad is scantily populated and covered with dense jungle; it has an unenviable reputation for being one of the most malarious tracts in Southern India. The higher *ghats* form a bold rocky barrier and the scenery is extremely beautiful. Notwithstanding its natural beauties and interesting inhabitants, the country being so thickly wooded is a tedious one to survey except on the higher hills. The position of each house has to be fixed as it would be misleading to attempt to block the villages in the usual conventional way. The standard sheets surveyed during the year were $49\frac{M}{11, 13, 15, 16}$ and $58\frac{A}{1, 2, 3, 4, 5}$. Sheet $57\frac{H}{14}$, comprising an area of 289 square miles in the Salem district, was also surveyed and mapped by a small training detachment of 14 native surveyors under Mr. G. T. Hall, a retired Provincial officer. The detachment was broken up on 30th September and the men transferred to other parties.

187. The mapping of this party is very backward and only 3 maps, $49\frac{M}{11, 15, 16}$, have been completed and forwarded to the reproducing offices. The following sheets were drawn in outline only:—$49\frac{M}{13}$ and $58\frac{A}{4}$ on the 2-inch scale and $58\frac{A}{1, 2, 3, 5}$ on the $1\frac{1}{2}$-inch for reduction to 1-inch. The drawing of the hill sheets will be taken in hand by the Burma Drawing office and it is hoped that all will be forwarded to Calcutta for publication by May 1909.

188. Triangulation was carried southward from latitude 11° through the Coimbatore district into Cochin and Travancore States. Nearly the whole of the province of Coorg and a small area in the Salem district were also triangulated. The boundaries of all forests which occurred in the area under survey were traversed by theodolite and also a portion of the Mysore-South Canara boundary. The computations of both triangulation and traversing are well advanced.

189. The party was inspected in the field and during recess by the Superintendent in charge Burma Surveys.

190. The programme for 1908-09 consists of the completion of degree sheets 58 A, $49\frac{N}{13, 14}$, and $58\frac{B}{9, 13}$ in Mysore State and in the Nilgiri, Malabar, and Coimbatore districts. As more than half the total area of the Nilgiri district consists of reserved forests it has been decided to survey the whole of the district on the 2-inch scale; the densely populated coastal tracts will also be surveyed on that scale and the remainder of the area on the 1-inch scale. The portion of the Mysore State occurring in the programme will be revised on the 1-inch scale. Triangulation will be carried into Travancore State and it is hoped that sheets 58 B and C will be completed.

EASTERN BENGAL AND ASSAM.

NO. 20 PARTY (*vide* INDEX MAP NO. 2).

191. Pending the final formation of Circles, the recess quarters of the party continued at Bangalore. Field work was commenced in the end of November 1907 and closed in the middle of May 1908 giving a field season of a little under six months.

Personnel.

Imperial Officer:

Major A. Mears, I.A., in charge.

Provincial Officers:

Messrs. P. F. Prunty, C. C. Byrne, J. H. Williams and L. Williams, Babu Pramadaranjan Ray, and Munshi Amjad Ali.

Subordinate Establishment:

30 Surveyors, 5 Traversers, 3 Computers, 3 Draftsmen, 2 Writers, 1 Hospital Assistant.

192. The outturn and cost-rates were as follows:—

Nature of Survey.	Outturn, sq. miles.	Cost-rates per sq. mile.	REMARKS.
		R	
Triangulation	1,731	12·8	
Traversing	620 (*a*)	20·90 (*a*)	(*a*) Linear miles.
Detail survey—			
Survey on the 2-inch scale	2,590	27·20	
Revision survey on the 2-inch scale	307	28·10	Cost-rates are inclusive of mapping.
Supplementary survey on the 2-inch scale	238	12·26	
TOTAL (DETAIL SURVEY)	3,135		

The scale of survey was 2 inches = 1 mile and the average monthly outturn of a surveyor was 20·4 square miles for original survey, 11·5 for revision survey, and 23·0 for supplementary survey. The reason for the slow progress of revision survey was the difficult and intricate nature of the ground which consisted of low bamboo-covered hills, while the remaining area was for the most part level cultivated country.

193. The total cost of the party for the year ending 30th September 1908 was R1,18,471.

194. On account of the intricate nature of the country and the number of villages, the survey was carried out on the scale of 2 inches = 1 mile with contours at vertical intervals of 50 feet. The revision survey was done in the field on blue prints of the original survey made in 1881-83 by Colonel Woodthorpe and Major Badgely. The general features were found to be accurate and were as a rule accepted by the surveyors, but the contouring had to be done *de novo*. The supplementary survey was done over blue-print reductions of the 16-inch cadastral sheets; the details were tested and found to be accurate but had to be supplemented by more careful surveys of village sites and of new roads.

195. The health of the party was on the whole very good. Two traversers died during the recess season and seven *khalásis* in the field.

196. The area topographically surveyed comprised portions of districts Sylhet, Tippera, and Mymensingh and of the Native State of Hill Tippera. The country was for the most part flat and open, closely cultivated and densely populated. It was intersected by numerous water-courses and tidal creeks, the major portion of the area being only 40 to 50 feet above mean sea level. The villages were for the most part surrounded by gardens thickly planted with bamboos, palms, and mangoe trees. One of the chief features of Sylhet is the great number of *bils*, some of which are large open sheets of water, while others are so overgrown with different kinds of reeds as to be practically impenetrable. The inhabitants, while not actually interfering with the work, evidently viewed the survey operations with suspicion and as a rule afforded little assistance or information to the surveyors. Supplies were plentiful but expensive and labour was scarce.

197. Ten standard sheets were surveyed and drawn on the 2-inch scale, and will be submitted for publication before the end of the year, namely, $78\ \frac{P}{1, 2, 3, 4, 5, 6, 7, 8, 11, 14}$.

198. The triangulation was connected with the Eastern Frontier G.T. Series and with No. 6 Party's triangulation of 1897-99. All computations have been completed and the results are satisfactory. The traversing was carried out with the object of furnishing additional heights in the area cadastrally surveyed and extra points for the plane-tabler in the low and thickly-wooded valleys where objects could not be fixed by the triangulator.

199. The party was inspected by the Superintendent in charge Burma Surveys in the field and in recess.

200. The programme for 1908-09 consists of the completion of the detail survey of sheet 78 P on the 1-inch and 2-inch scales and the detail survey on the 2-inch scale of sheets 83 $\frac{D}{10, 11, 14, 15}$ in which large forest reserves are situated. The triangulation and traversing of sheet 83 D north of latitude 24° 15′ will also be completed. It is not proposed to carry the survey to the south of that latitude at present, as the country there is very thinly populated and not of much importance.

NORTHERN CIRCLE.

No. 9 Party (*vide* Index Map No. 1).

201. This party continued the work on which it was employed during the preceding season in and about Dera Gházi Khan district of the Punjab. This consisted of original topographical surveys on the scale of 2 inches = 1 mile, and 1 inch = 1 mile, for publication on the 1-inch scale.

Personnel.

Imperial Officers:

Lieutenant E. C. Baker, R.E., in charge up to 24th April 1908, and from 14th September 1908.

Lieutenant F. J. M. King, R.E., in charge from 25th April 1908 to 13th September 1908.

Provincial Officers:

Messrs. J. A. Freeman, H. C. W. Stotesbury, D. K. Rennick, R. C. Hanson, and H. W. McDonald.

Subordinate Establishment:

24 Surveyors, 3 Computers, 2 Writers, and 4 Soldier Surveyors.

202. The work in the hills was based on last season's triangulation and in the plains on traverses executed in 1872-75. 2-inch reductions of the old 4-inch riverain maps were utilised to a certain extent for the work in the plains.

203. The field office opened at Dera Gházi Khan on 27th October 1907 and closed on 15th April 1908.

204. The outturn of the party for the season is as follows:—

Original 1-inch survey	1,542·6	square miles.
„ 2 „ „	770·4	„
TOTAL	2,313·0	„

The 1-inch work comprised the whole of standard sheets $39\ \frac{J}{2, 3, 4, 6, 7, 8}$ and the 2-inch „ „ „ „ „ „ „ $39\ \frac{J}{9, 10, 11}$.

Minor and tertiary triangulation was carried through standard sheets $39\ \frac{I}{3, 4, 7, 8}$ and $39\ \frac{J}{1, 5}$; a total area of 1,534·04 square miles.

205. The cost-rates for survey are —

	Per square mile. R
2-inch original survey	22·1
1- „ „ „	27·5
Triangulation	5·7
Mapping	6·4

The cost of 1-inch exceeds that of the 2-inch work, as the 1-inch work was all in hilly country where transport allowances and warm clothing charges were very high, while the 2-inch work was in the plains. The total cost of the party for the year under report was R85,163.

206. During recess, all the nine standard sheets surveyed during the year, *viz.*, 39 $\frac{J}{2, 3, 4, 6, 7, 8, 9, 10, 11}$ and also sheet 39 $\frac{K}{1}$ (surveyed during 1906-07) were drawn and forwarded to the Superintendent, Northern Circle, for submission to the reproducing offices.

207. The character of the ground surveyed was varied. Sheets 39 $\frac{J}{2, 3, 4, 6, 7, 8}$ consisting of very hilly, broken country rising from 600 feet above sea level in the east to 7,000 feet in the west. The plain country in sheets, 39 $\frac{J}{9, 10, 11}$ lying just to the west of the Indus is flat and sandy, and except for a strip of country along the Indus is extremely dry.

208. The party was inspected in the field by the Superintendent, Northern Circle, in December 1907, and March 1908.

209. The programme for next field season will be detail survey on the scale of 1 inch = 1 mile, in portions of sheets 39 I and J and triangulation in 39 I and E.

NORTHERN CIRCLE.

No. 12 Party (*vide* Index Map No. 1).

210. Captain and Brevet-Major E. T. Rich, R.E., was in charge of the party for practically the whole year.

Personnel.

Imperial Officers:

Captain and Brevet-Major E. T. Rich, R.E., in charge, Captain L. C. Thuillier, I.A., from 1st August 1908. Lieutenant S. W. Hamilton, R.E.

Provincial Officers:

Messrs. W. Newland, F. H. Grant, and H. H. P. Butterfield, Munshis Rahamatulla, K.S., and Abdul Karim, and Babu Dhani Ram.

Subordinate Establishment:

27 Surveyors, Computers, Writers, etc., and 3 Soldier-Surveyors.

211. The party carried out the sanctioned programme in the Peshawar and Hazára districts and a small portion of the Attock district, as follows:—

(*a*) A network of triangulation in the Hazára district over an area of 1,200 square miles.

(*b*) Detail survey on 2-inch scale of an area of 1,582 square miles.

212. The detail survey work was tested by 1,179 "*in situ*" fixings.

213. The cost-rates are as follows:—

	Per square mile. R
2-inch detail survey	34·8
Triangulation	11·4
Fair mapping	8·2

The cost-rate this season for 2-inch detail survey is satisfactory, being R19 per square mile lower than that of last year.

214. The total cost of the party for the season under report was R85,844.

215. The work in the field was closed on 15th June 1908 when the party returned to Mussooree for recess.

216. During the recess the following standard sheets surveyed during the year were drawn and forwarded to the Superintendent, Northern Circle, for submission to the reproducing offices: 38 $\frac{O}{5, 9, 13}$, 43 $\frac{C}{1}$.

Sheets 38 $\frac{N}{8, 12, 16}$ and 43 $\frac{B}{4}$ will be submitted in January 1909, but sheet 38 $\frac{N}{11}$ is retained for additional survey.

217. The health of the party during the field season was very satisfactory.

218. The party was inspected twice during the field season by the Superintendent, Northern Circle, and once during the recess by the Officiating Surveyor General and three times by the Superintendent, Northern Circle.

219. It will undertake next field season detail survey in sheet 43 $\frac{B}{8}$ (remainder), 43 $\frac{B}{7, 11, 12, 15, 16}$, and western halves of 43 $\frac{F}{7, 8}$ and triangulation in the Hazára district.

NORTHERN CIRCLE.

No. 14 Party (*vide* Index Map No. 1).

Personnel.

Imperial Officers:

Captain H. L. Crosthwait, R.E., in charge frm 11th October 1907 to 5th May 1908. Lieutenant V. R. Cotter, I.A., in charge from 1st to 10th October 1907. Lieutenant O. H. B. Trenchard, R.E., in charge from 6th May 1908. Captain L. C. Thuillier, I.A., from 24th October 1907 to 13th April 1908.

Provincial Officers:

Messrs. T. W. Babonau, H. H. B. Hanby, H. B. Simons, C. West, A. B. Hunter, W. J. B. Miller, and F. C. Saint.

Subordinate Establishment:

38 Surveyors, etc.

220. The operations of the party lay in the Kohát and Attock districts.

221. The detail survey on the 2-inch scale of the whole of the Kohát district has now been completed, and also two complete standard sheets in the Attock district.

222. Operations in the field commenced in the middle of November 1907, and the party returned to recess quarters in Mussooree about middle of May 1908.

223. The country surveyed was on the whole suitable for survey operations, being practically destitute of forest growth. Portions of the Kohát district are mountainous and difficult of access, but nearly the whole of the Attock district consists of undulating country, intersected by deep ravines. Owing to prevailing drought the surveyors experienced difficulty in obtaining water.

224. The area surveyed on a scale of 2 inches = 1 mile was 2,103 square miles.

225. The area triangulated amounted to 1,365 square miles, which with the balance of 1,705 square miles previously triangulated gives a total of 3,070 square miles available for survey during the coming season.

226. The cost-rates are as follows:—

	Per square mile. ₹
Detail survey 2-inch scale	30·5
Triangulation	7·2
Mapping	7·7

and the total cost-rate of ₹45·4 per square mile compares favourably with last year's rate of ₹57·5.

227. The total cost of the party for the year under report was ₹95,003.

228. The fair mapping of the following 11 standard sheets (drawn on the scale of 2 inches = 1 mile, for reduction to 1 inch = 1 mile, and surveyed during the year under report), was taken up during recess, *viz.*, 38 $\frac{O}{2, 6, 8, 10, 11, 12, 14, 15, 16}$ and 43 $\frac{C}{2, 3}$, and they will be forwarded to the Superintendent, Northern Circle, for submission to the reproducing offices in January and February 1909.

229. The party was inspected in the field by the Superintendent, Northern Circle, in December 1907.

230. The programme for the next field season provides for a continuation of the work in an easterly direction between the latitudes of 33° and 34°, to complete the detail survey of the Hazára district in degree sheet 43 C, and for triangulation in degree sheet 43 G.

NORTHERN CIRCLE.

No. 18 PARTY (*vide* INDEX MAP No. 1).

231. The head-quarters of the party remained at Dera Ismail Khan throughout the field season, opening there on 11th November 1907.

Personnel.

Imperial Officers:

Captain E. A. Tandy, R.E., in charge.
Lieutenant V. R. Cotter, I.A.

Provincial Officers:

Messrs. G. J. S. Rae, C. E. C. French, J. R. Newland, P. D. Simpson, and F. C. Pilcher, Babu Maya Das Puri, and Munshi Abdul Aziz.

Subordinate Establishment:

25 Surveyors, 13 Traversers, 17 Draftsmen, 10 Computers, 3 Writers, and 1 Hospital Assistant.

232. Surveyors were concentrated at first in the area comprised by standard sheets 38 $\frac{L}{15, 16}$, and 38 $\frac{P}{3, 4}$, in three camps, under Lieutenant Cotter and Messrs. French and Simpson, and two surveyors were deputed to survey the bed of the Indus on the scale 1 inch = 1 mile, starting in the centre of 38 $\frac{P}{7}$, while two traversers were employed in sheets 39 $\frac{I}{13}$ and 39 $\frac{M}{1}$. The sheets surveyed were 38 $\frac{L}{8, 15, 16}$, 38 $\frac{P}{3, 4}$, and 39 $\frac{I}{13}$.

233. On the completion of the triangulation in January, detail survey work was continued in sheets 38 $\frac{L}{3, 4, 7, 8}$, and triangulation was carried on in sheets 38 $\frac{P}{1, 2, 5, 9, 10, 14}$, and by the end of March work was started on the 1-inch scale in sheet 39 $\frac{I}{13}$.

234. The outturn and cost-rates were as follows:—

		Per square mile.
		₹
2-inch surveys	1,267 square miles at	35·0
1 " "	539 "	7·4
Triangulation	1,712 "	9·1

The rates for the two scales of survey are not fairly comparable as some of the 2-inch work was very difficult, while the 1-inch work was nearly all easy, falling in the bed of the Indus and involving no contouring.

235. The total cost of the party for the year under report was ₹1,24,401.

236. The largest monthly outturn of a surveyor on 2-inch work was 41 square miles in very open plains, the least being 5½ square miles. The average monthly outturn of 1-inch work was 42 square miles.

237. The traverse outturn was 462 linear miles at ₹7·4 per mile. It was only supplementary to points already existing, and included the taking of vertical angles to fix heights.

238. Surveyor Garjman Rai was employed from September 1907 to January 1908 in bringing up to date the maps of the country all round Simla, to facilitate the production of a special 1-inch map of that area. He was also employed from May to July 1908 in assisting local officials to fix a boundary in the Simla Hill station (Tehri-Garhwál, Keonthal, and Jaunsár).

239. Standard sheets 38 $\frac{L}{8, 16}$, 38 $\frac{P}{4}$, and 39 $\frac{I}{13}$ were completed and forwarded to the Superintendent, Northern Circle, for submission to the reproducing offices, and 38 $\frac{L}{15}$ and 38 $\frac{P}{3}$ will be forwarded in January 1909.

240. *Bári Doáb Traverse.*—This was carried out under Mr. Rae, with head-quarters at Montgomery. Eleven traversers were originally allotted to this work, but during the season about half were gradually drafted away to meet the requirements of the Riverain section, thereby disturbing progress considerably. Difficulties in regard to transport and labour in the desert were again considerable. The outturn was about 1,000 linear miles of traverse, fixing nearly 400 bases. It is proposed to complete the remainder of the area next season.

241. *Riverain Work.*—This was continued by Babu Maya Das Puri with head-quarters at Lahore.

242. The Superintendent, Northern Circle, inspected the party in the field in December 1907 and April 1908, and frequently during the recess. It was also inspected by the Officiating Surveyor General in September 1908.

243. The programme for next season involves the completion of sheets 38 $\frac{L}{3, 4, 7}$, 38 $\frac{P}{1, 2, 5, 6, 7, 8, 9, 10}$, 39 $\frac{I}{5, 9}$, and 39 $\frac{M}{1}$. Of these sheets, 38 $\frac{L}{7}$ and 39 $\frac{I}{5, 9}$, and the bed of the Indus, with all country east of it, will be surveyed on the 1-inch scale and triangulation and traverse will be carried out in sheets 38 P and 43 D.

NORTHERN CIRCLE.

TRAINING PARTY (*vide* INDEX MAP NO. 1).

244. The office in Dehra closed on 18th October 1907 and re-opened at Sohâwa railway station in the Jhelum district on 23rd October. Owing to a wagon containing the equipment of the party having broken down on the railway, field work was not commenced till middle of November.

Personnel.

Provincial Officers:

Mr. G. P. Tate in charge, and Mr. M. C. Petters.

Subordinate Establishment:

5 Instructors, 22 Surveyors, 2 Traversers, 1 Computer, and 2 Writers.

245. A portion of Kashmir State was included in the season's outturn of work in sheet 43 $\frac{G}{12}$.

246. The scale of survey was 2 inches=1 mile. Standard sheets 43 $\frac{G}{12}$ and 43 $\frac{H}{5}$ have been completed, but owing to the lack of finished draftsmen in the party they could not be fair drawn, but they together with 43 $\frac{H}{9}$ (surveyed in 1906-07) have been sent to the Superintendent, Northern Circle, for final preparation in his office during the winter of 1908-09.

247. An area of 487 square miles was surveyed on the 2-inch scale and 790 square miles triangulated. Cost-rates have been omitted as this is a training party.

248. The total cost of the party for the season under report was R41,307.

249. Degree sheets 43 C, D, G, and H were partly triangulated.

250. The health of the party was good throughout the year. It returned to recess quarters at Dehra on 15th May 1908, and will be broken up on 31st October 1908.

CADASTRAL AND TRAVERSE SURVEYS.

BENGAL AND EASTERN BENGAL (*vide* INDEX MAP NO. 2).

251. The operations in Bengal and Eastern Bengal were under the supervision of Captain F. C. Hirst, I.A., Officiating Superintendent, Provincial Surveys, Bengal, throughout the year. The work was carried out by three parties, two of which, in addition to traverse work, carried out topographical surveys.

252. The outturn for the year under report in square miles is as follows:—

	Bengal.	Eastern Bengal.
Traversing	3,609	2,694
Topographical Surveys, 2″=1 mile	1,440	...

No. 4 PARTY (BENGAL).

253. The party was employed on traverse work in the Patna, Shahabad, and Monghyr districts, and also carried out a number of petty surveys.

Personnel.

Provincial Officers:

Messrs. N. Bedford (in charge), E. G. Hardinge, O. J. H. Hart, and J. H. Johnson.

Subordinate Establishment:

1 Military Hospital Assistant, 7 Accountants and Writers, 29 Computers, Draftsmen, etc., 47 Traversers and Surveyors, and 640 Menials.

254. The outturn for the season with cost-rates per square mile is as follows :—

District.	Nature of operations.	Area in sq. miles.	Cost-rate per sq. mile.
			₹
Patna	Traverse	1,142	41·0
Shahabad	Do.	347	37·3
Various	Petty surveys excluding linear relaying work.	42	...
	TOTAL	1,531	...
Monghyr	Topographical survey 2″ = 1 mile	183	40·8

255. The cost-rates are fair to good.

256. The total cost of the party for the year under report was ₹74,263.

257. The traversing has been suitably connected with the Great Trigonometrical Survey and proves well.

In the programme detailed in the table above, there were 32,792 theodolite stations which were marked by 5,349 stones at village trijunctions, 25,285 cylinders, 321 bricks, 27 iron pegs along the municipal limits, and 1,810 wooden pegs.

The Revenue Survey maps were used as guides in obtaining the boundaries. The traverse boundaries agree very well with the Revenue Survey boundaries.

The demarcation was generally found to be good.

258. The programme for next year is the traverse survey of about 1,600 square miles of the Shahabad district.

NO. 5 PARTY (BENGAL).

259. From the 1st November 1907 the head and traverse camps were amalgamated. Traverse operations were carried on in districts Ranchi, Midnapore, Singhbhum, and Manbhum. Besides these, a number of petty surveys were carried out.

Personnel.

Provincial Officers:

Messrs. C. S. Kraal (in charge), C. H. G. Johnson, and I. Newton.

Subordinate Establishment:

2 Supervisors, 6 Writers and Accountants, 29 Computers, Draftsmen, etc., 40 Traversers, and 629 Menials.

260. The outturn for the season with cost-rates per square mile is as follows :—

District.	Nature of operations.	Area in sq. miles.	Cost-rate per sq. mile.
			₹
Ranchi	Traverse	1,208	34·3
Ranchi Municipality	Ditto	7	...
Midnapore	Ditto	211	33·1
Singhbhum	Ditto	14	35·6
Manbhum	Ditto	638	41·6
	TOTAL	2,078	
Mayurbhanja Dispute	Ditto	18	Linear miles.
Sikkim Mining claims	Ditto	2	

The cost-rates are good, considering the scattered nature of the programme.

261. The total cost of the party for the year under report was ₹78,182.

262. The traverse work was connected with twelve stations of the Great Trigonometrical Survey. There were in all 45,513 theodolite stations. Of this

number 3,789 were trijunctions marked by stones, and the remaining 41,724 were marked by galvanized and baked clay cylinders, country stones, iron and wooden pegs and marks cut on rocks "in situ."

263. The demarcation in Midnapore district was fairly well done, but in the remaining districts no attempts were made to demarcate the village boundaries. Owing to the hilly and undulating nature of the country under survey the subtense bar was frequently used. As there were no old existing maps showing village boundaries, the villages were surveyed as pointed out by the inhabitants.

264. The programme for next year consists of about 300 square miles of traversing in the Manbhum and 1,300 in the Hazáribágh districts.

No. 6 Party (Eastern Bengal).

Personnel.

Messrs. A. W. Smart, (in charge), P. F. Delaney, L. B. Fitz-Gibbon, B. F. Cooper, O. E. C. Judd, T. F. Kitchen, C. A. O'Donel, O. J. H. Hart and P. E. Kennegy.

Subordinate Establishment:

1 Supervisor, 13 Writers and Accountants, 48 Computers and Draftsmen, 97 Traversers and Surveyors, 5 Hospital Assistants, and 1,486 Menials.

265. The party comprised two traverse and one traverse and topographical sections.

266. The outturn for the season with cost-rates per square mile is as follows:—

District.	Nature of operations.	Area in sq. miles.	Cost-rate per sq. mile.
			₹
Jalpaiguri	Traverse	1,395	47·8
Mymensingh	Ditto	876	56·1
Faridpur	Ditto	355	59·1
Dacca	Ditto	68	81·9
	TOTAL	2,694	
Khulna	Traverse for Topography	1,257	55·8
Do.	Topography 2″ = 1 mile	1,257	42·5

The above figures exclude work done in the relaying of the Jalpaiguri-Bhutan, Jalpaiguri-Cooch Behar boundaries, and certain miscellaneous work.

The cost-rates are good for the nature of the country dealt with, which with the exception of Mymensingh district was either very unhealthy or very low lying, and it contained certain "*diara*" river-bed tracts. The rate for Mymensingh is high, because it includes the initial expenditure contingent on the organization of a new section which was formed in October 1907.

267. The total cost of the party for the year under report was Rs. 2,80,192.

268. The survey of the Sundarbans forests is now completed to the relief of all who were connected with it. As in previous years, food and water have been carried by a flotilla of launches and boats for the whole establishment. The system of survey used was that adopted in previous years.

269. Excluding the Sundarbans 42,168 points were marked as theodolite stations.

270. The prugramme for the next survey year is the continuance of the traverse survey of the Jalpaiguri, Mymensingh, and Dacca districts. It also includes an awkward river-bed programme in the lower reaches of the Ganges, Padma, and Meghna rivers.

UPPER AND LOWER BURMA.

No. 7 Party.

271. The party was under the administrative charge of Lieutenant-Colonel P. J. Gordon, I.A., throughout the year. The operations consisted of the completion of the cadastral survey in the Thayetmyo district and of that part of the Pyapôn district which had been traversed during the previous year, and the traverse and cadastral survey of parts of the Yamèthin and Pegu districts. The programme was completed, and with it cadastral survey operations in Burma come to an end as far as the Survey of India is concerned, and the party will be broken up in November 1908.

Personnel.

Provincial Officers:

Messrs. O. D. Smart (in charge), C. G. Lee, C. S. Littlewood, and W. E. S. Swiney, Babu Jagadamba Prasad.

Subordinate Establishment:

10 Traversers, 10 Computers, 13 Draftsmen, 2 Typers, 4 Estimators, and 69 Field Surveyors.

272. The outturn and cost-rates were as follows :—

Locale.	Traversing.			Detail Survey.							Remarks.
	Kwins.	Square miles.	Cost per square mile including demarcation.	*Kwins.*	Sheets.	Fields.	Area in acres.	Area in square miles.	Cost per square mile.	Average size of field in acres.	
			₹						₹		
Thayetmyo	...	..	...	311	811	(*b*) 155,964	(*b*) 397·976	(*c*) 622	104·4	(*a*) 1·06	Scale 16 inches = 1 mile.
„ Water area.	..	...	...	...	...	...	9,650	15			
Pegu	98	214	86	98	242	(*b*) 75,500	(*b*) 111,220	174	76·6	(*a*) 0·64	
„ Water area	...	...	...	...	...	..	21,126	33			
Yamèthin	137	114	187	137	211	(*b*) 29,350	(*b*) 73,062	114	149·2	(*a*) 0·53	
Pyapôn	...	...	...	5	16	605	7,125	11	280·2	(*a*) 3·32	
„ Water area	...	...	...	...	...	...	428	1			
	235	328	...	551	1,280	261,419	620,587	970	...	...	

(*a*) Calculated on the cultivated area only.
(*b*) Includes jungle.
(*c*) Includes jungle but excludes 25 square miles of forest reserve not mapped.

273. The party took the field in the middle of November 1907, and returned to recess quarters at Maymyo at the end of May 1908.

274. *Thayetmyo.*—An area of 637 square miles was surveyed on the 16-inch scale in the Allanmyo and Minhla townships; of this area only 241 square miles comprising 145,260 fields of an average size of 1·06 acres were cultivated. The remaining area, 396 square miles, consisted of water, hills, and jungle in which no detail except large streams and important cart-tracks were surveyed; in this country the traverse lines were as a rule upheld as *kwin* boundaries. The work was checked by 174 linear miles of test lines by officers of the party and 433 linear miles of independent test lines, giving an average of 2·5 linear miles of test survey to each square mile of cultivation; 927 linear miles of test lines were also run by native Inspectors in the same area. The average numbers of *amin* employed was 49 for 174 days, and the average daily outturn of each *amin* was 18 acres comprising 17 fields.

It was found necessary to run 14 linear miles of sub-traverses in this district, to include extensions of cultivation that had occurred since last year when the traversing of the district was done.

275. *Pegu.*—The work in Pegu district consisted of the traverse and cadastral survey of 207 square miles of newly-formed *kwins* in the Thanatpin township; of this area only 66 square miles comprising 66,531 fields of an average size of 0·64 acres, were cultivated. The whole area was surveyed in detail on the 16-inch scale and *kwin* boundaries were surveyed as demarcated on the ground. The work was checked by 23 linear miles of test lines by officers of the party, supplemented by 186 linear miles of independent lines, giving an average of 1·2 linear miles of test survey to each square mile mapped; 378 linear miles of test lines were also run by native Inspectors. The average number of *amins* employed was 25 for 50 days and the average daily outturn was 95 acres comprising 54 plots.

The traversing in this district covered an area of 214 square miles, and amounted to 635 linear miles. The theodolite was set up at 2,781 stations of which 2,201 were new and were marked with galvanized iron cylinders at an approximate cost of 5 annas per station. The origin of survey was—latitude 17° 00′ 00″ and longitude 96° 00′ 00″.

276. *Yamèthin.*—The operations consisted of the traverse and cadastral survey of an area of 114 square miles of scattered blocks in the Pyinmana township; of this area only 21 square miles comprising 25,563 fields of an average size of 0·53 acres were cultivated, the remainder consisting of hills and jungle in which no detail was surveyed except large streams and important cart-tracks. The work was checked by 20 linear miles of test lines by officers of the party, and 114 linear miles of independent test lines, giving an average of 6·4 linear miles to each square mile of cultivation; 252 linear miles of test lines were also run in the same area by native Inspectors. The average number of *amins* employed was 19 for 59 working days, and the average daily outturn of each *amin* was 16 acres and 25 fields.

The traversing in the Yamèthin district consisted of 452 linear miles; double chaining was employed throughout as well as subtense bars for measurements when necessary. The theodolite was set up at 4,184 stations of which 3,610 were new and were marked with galvanized iron cylinders at an approximate cost of 13 annas per station. The work was connected with one trigonometrical station. The origin of survey was—latitude 20° 30′ and longitude 96° 15′.

277. *Pyapôn.*—The cadastral survey consisted of an area of 12 square miles left over from last year's programme, owing to inundations late in the season.

278. The area surveyed in Thayetmyo consisted to a large extent of hills covered with scrub jungle. The cultivation consisted largely of *taung-ya* cultivation, where the fields have no defined boundaries and are usually allowed to lie fallow for several years. This caused considerable delay and difficulty to the surveyors and the field season was much prolonged in consequence. In Pegu the area surveyed consisted of land recently formed by the silting up of the Sittang river; a considerable stretch of land on the eastern or Thatôn bank has been eaten away, and a stretch of land ten miles in width has been added to the Pegu district. This area has been divided into *kwins* and is being rapidly taken into cultivation.

The area surveyed in Yamèthin consisted chiefly of hills and jungle; the *kwins* averaged less than a square mile a piece and were insufficiently demarcated and therefore troublesome to survey.

279. The cost-rates are on the whole fair. In Thayetmyo the cost-rate of cadastral survey was R104·4 per square mile which compares favourably with the rates in the same district for the previous year. In Pyapôn the cost-rate of cadastral survey was R280·2 as compared with R205 for the previous year. The small area surveyed accounts for the increase. In Pegu traversing cost R86 and cadastral survey R76·6 per square mile, which rates may be considered satisfactory. In Yamèthin, as anticipated, the rates are very high both for traversing and cadastral survey. This was due partly to the nature of the country, which was in a hilly and jungle-clad tract, but principally to defective demarcation which entailed much loss of time in determining where traverse lines should be run and where the *kwin* boundaries

should be. The *amins* in this district were paid fixed salaries instead of by contract.

280. The total cost of the party for the year under report was R1,57,847, inclusive of charges for instruments for the local Government.

281. The health of the party was generally good; 5 deaths occurred during the field season and 3 men were invalided.

282. The party was inspected by Colonel Gordon during the field season.

283. Forty traverse charts have been sent to press during the year. A considerable number of traverse charts will remain when the party is broken up, but it is not contemplated to complete these at present. All original traverse computations will be made over to the Deputy Commissioners of the districts to which they belong for safe custody, the original traverse field books being deposited in the Map Record office, Calcutta. The detail survey carried out by the party has been added to the original fair sheets of which reprints or new editions will be published and all 16-inch maps were completed and sent to press.

CANTONMENT SURVEYS.

No. 1 Section.

284. During the season under report, this section was employed on the survey of the cantonments in portions of the Pesháwar, Ráwalpindi, Meerut and Lucknow divisions, and of Bannu in the Bannu brigade. Mr. F. S. Bell, Extra Assistant Superintendent, 4th grade, remained in charge till the 25th October, when he was relieved by Mr. E. G. Little, a retired officer of the Provincial service transferred from Bangalore, who carried on the duties till the end of the season.

285. The survey of the following cantonments was completed:—Nowshera Cavalry cantonment, Mardán, Abbottabad, Almora, Ranikhet (including Chaubattia), Naini Tál, Benares and Bannu, Landour and the 7 gallies (namely:—Baragali, Kálábágh, Ghora Dhaka and Khanspur, Changlagali, Khayragali and Barian) wil be completed by the end of October. A small area added to Delhi by an extension of the boundary, was also surveyed.

286. The maps of Lansdowne, Almora, Shahjahanpur, and the bazaars of Ránikhet of Section No. 1, and Fort Saint George, Pallávaram, Cannanore, Trichinopoly, Poonamallee, and the bazaars of Bangalore of Section No. 3, were sent for publication, and those of Kasauli, Muttra, Lansdowne, and Ránikhet bazaars of Section No. 1, and Pallávaram, Trichinopoly, and Bangalore bazaars of Section No. 3 were published.

287. The areas surveyed during the season and the cost-rates were:—

	Acres.	Rupees per acre.
Triangulation	2,264	0·45
Traversing	12,894	0·45
Detail survey on 16-inch scale	21,380	0·70
„ „ on 64- „ „	153	5·69
Mapping on 16-inch scale	8,611	0·37
„ on 64- „ „	707	1·60

The cost of the 64-inch field work is high owing to the smallness of the area surveyed.

The average outturn per working day was—

Traversing, 8 angles and 82 chains—	
Detail survey on 16-inch scale	16 acres.
„ „ 64- „ „	1·20 „

288. The total cost for this section for the year under report was R26,850.

289. The maps of the following cantonments:—Delhi, Sitápur, and Naini Tál and the remaining bazaar of Belgaum will be submitted for publication during October. The Deputy Surveyor General inspected this section during December 1907.

290. Next season it is proposed to survey the cantonments in Bengal.

SECTION NO. 2.

291. This section was engaged on the completion of the surveys of the cantonments of the Poona and Mhow divisions, and remained in charge of Mr. L. Pocock, a retired officer of the Provincial Service, throughout the year under report. In all, nine cantonments were dealt with, the cantonments themselves being surveyed on the scale of 16 inches=one mile and their bazaars on the scale of 64 inches=one mile, while all were contoured with contours run at 5 feet vertical interval. The surveys on the cantonments of Nasirabad, Mount Abu, Neemuch, Aurangabad, and Ahmednagar commenced during the previous year were completed, and those of Jubbulpore, Mhow, Sehore, and Pachmarhi were undertaken and completed, with the exception of a small amount of contouring remaining to be finished in Jubbulpore and Pachmarhi, which will be finished during October, leaving no further work to be done in the two divisions.

292. The maps of seven cantonments, *viz.*, Devláli, Mount Abu, Ajmer, Nasirabad, Aurangabad, Ahmednagar, and Neemuch have been completed, and forwarded to the Trigonometrical Office for publication, and those of Mhow and Sehore have been far advanced.

293. The season's outturn and cost-rates are as under:—

				₹
Traversing			4,462 acres at 0·79 per acre.	
Detail survey including mapping and contouring		on 16-inch scale	15,117.	„ 1·16 „
Ditto	ditto	„ 64 „ „	418	„ 8·75 „
Ditto	ditto	„ scale 50 feet=1 inch	34	„ 12·91 „

Most of the traversing was done for the work on the scale of 1 inch=50 feet entailing very numerous stations, which accounts for the apparently enhanced cost.

294. The total cost for this section for the year under report was ₹23,662.

295. The average daily outturn of 16-inch survey was 15·3 acres, and of 64-inch 1·7 acres without contouring. With contouring, the outturn was 11·2 acres on the 16-inch scale. The cost-rate of the 16-inch survey without contouring was Ro·54 per acre, and of the 64-inch ₹4 per acre.

296. The Deputy Surveyor General inspected the section at Poona in December 1907 and again in July 1908 at Pachmarhi. He also tested the work of the section in the field at Jubbulpore in January 1908, and in Pachmarhi in July 1908.

297. During next season the survey of the bázaars, 42 in number, of Secunderabad and Bolarum will be undertaken on a scale of 1 inch=50 feet, or 105·6 inches=one mile. A large amount of the necessary preliminary traverse has been completed, and 64 of the sheets have been plotted in readiness for the coming season's work. Thirty four and a half acres of detail survey have also been done. The area of the 42 bazaars is about 1,800 acres or approximately 3 square miles, which on the large scale required will fully occupy the section during the whole season.

Summary of the Outturn of work of the Field Parties during the year 1907-08.

TOPOGRAPHICAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	Locale of Operations.	Triangulation.												Traverse.					Detail Survey.				
			Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Minor.			Tertiary.			Intersected Points.		Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Number of "*in situ*" test fixings.	Linear miles of Forest boundary traverse.
							Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Number of points fixed.	Error per mile in feet.										
1	1	Central and United Provinces and Central India States.	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	351(*d*)	15	...	...	...
	2	Berar	6	2,180	3·9	4·0	35	9·0	0·3	66	12·5	0·3	436	0·4	...	...	...	...	...	593	20	198	260	...
	3	Upper Burma	6	1,070	6·9	7·1	22	10·5	0·1	7	17·6	0·2	125	0·4	...	188	1,292	(*b*)	(*b*)	414 1,688(*c*)	16 14	25 191	104 447	...
	9	Northern Circle	6	1,534	6·2	6·9	...	...	...	19	6·0	0·2	223	0·8	...	...	...	...	...	1,543	12	7	465	...
	10	Upper Burma	6	3,337	4·5	4·7	25	6·7	0·1	21	7·7	0·1	687	0·6	...	...	...	...	...	1,707 69(*a*) 867(*c*)	15	169	1,085	...
	17	Bombay Presidency	6	3,375	...	...	...	...	...	115	8·0	0·5	552	0·9	...	...	...	...	...	...	...	...	...	...
	18	Northern Circle	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	539	11	...	...	...
	19	Madras Presidency	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	303 302 *a*)	8 10	5 3	34 15	...
	20	Assam	6	634	4·6	4·7	...	..	...	12	13·6	0·1	131	0·7	...	...	...	...	...	..	...	...	...	...
1½	11	Southern Shan States	6	3,900	4·4	4·5	62	10	0·2	...	...	...	(*b*)	(*b*)	...	...	...	...	...	2,303	7	...	424	...
2	1	Central and United Provinces and Central India States.	6 & 7	2,274	2·8	2·8	58	7·5	0·1	35	10·8	0·1	732	1·3	...	636	3,749	5·4	0·9	177(*d* 2,619(*a*)	27 12	...	...	...
	2	Berar	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	723	56	370	935	...
	3	Burma	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	299	98	31	169	...
	4	Bengal—Monghyr	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	183	...	146	172	...
	6	,, —Khulna	5 & 6	...	...	...	...	...	...	...	...	...	...	...	1,257	...	...	...	...	1,257	...	1,119	...	...
	9	Northern Circle	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	770	24	281	...	...
	10	Upper Burma	6	...	...	...	...	...	...	...	...	...	...	...	...	248	2,786	1·8	2·2	465	79	108	955	...
	12	Northern Circle	6	1,200	...	...	11	7·3	0·1	18	6·8	0·2	(*b*)	(*b*)	...	...	...	...	...	1,582	28	...	...	...
	14	,, ,,	6	1,365	2·8	2·8	...	...	...	39	6·3	0·2	442	0·4	...	...	...	...	...	2,103	20	...	579	...
	17	Bombay Presidency	6 & 7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	1,108(*a*) 1,250(*d*)	25	714	1,135	...
	18	Northern Circle	6	1,712	2·8	2·9	...	...	...	67	7·3	1·4	637	...	...	1,851	6,825(*e*)	...	...	1,267	27	...	...	...
	19	Madras Presidency	6	5,531	3·7	3·7	39	6·2	0·1	85	8·6	0·2	1,355	(*b*)	...	167	3,871	1·4	1·4	1,441 71(*a*)	33 3	100 6	577 3	...
	20	Assam	6	1,097	3·0	3·0	...	...	...	25	7·3	0·1	280	0·7	232	620	4,156	3·5	2·3	2,590 307(*a*) 238(*c*)	25 43 22	747	637	...
		Northern Circle Training	8	780	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	487	..	...	...	...
		Southern Circle Training	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	289	...	...	...	...
4	2	Berar	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20	122	286
	10	Upper Burma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	188	...	18	...
	17	Bombay Presidency	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	42
	19	Madras Presidency	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	39	75	57	117	...

(*a*) Revision survey.
(*b*) Computation incomplete.
(*c*) Supplementary survey.
(*d*) Re-survey.

Summary of the Outturn of work of the Field Parties during the year 1907-08.

CADASTRAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Traversing.						Detail Survey.				Record writing.			
			Instrument used. Diameter in inches.	Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error *per mile.*	Area in square miles.	Linear miles of test lines.	Number of villages.	Number of fields.	Average size of fields in acres.	Area in square miles.	Number of villages.	Number of fields.
16	4	Bengal, Monghyr	5 & 6	42	129	615	...	...	...	...	...	...	...	...	...	...
		„ Shahabad	...	347	1,373	9,285	0·3	0·2	...	...	...	...	...	...	...	...
		„ Patna	...	1,142	4,977	32,239	6·3	0·2	...	...	...	...	...	...	...	...
	5	„ Midnapore (Jhagran estate)	5 & 6	211	912	5,392	0·9	0·2	...	...	...	...	...	...	...	...
		Bengal, Singhbhum (Babhiram Tung)	...	14	46	339	...	...	...	...	...	...	...	...	...	...
		Bengal, Ranchi	...	1,208	3,760	24,612	0·6	0·5	...	...	...	...	...	...	...	...
		Bengal, Manbhum (Baráhabhúm)	...	638	2,213	13,998	0·4	0·3	...	...	...	...	...	...	...	...
		Bengal, Ranchi Municipality	...	7	50	645	...	...	...	...	...	...	...	...	...	...
	6	Eastern Bengal, Jalpaiguri	5 & 6	1,395	3,596	21,098	1·3	0·3	...	...	...	...	...	...	...	...
		Eastern Bengal, Mymensingh	...	876	3,069	13,902	3·7	1·8	...	...	...	...	...	...	...	...
		Eastern Bengal, Faridpur	...	355	1,303	5,961	2·0	2·7	...	...	...	...	...	...	...	...
		Eastern Bengal, Dacca	...	68	319	1,477	4·0	4·5	...	...	...	...	...	...	...	...
	7	Burma, Thayetmyo	6	...	14	127	..	...	637	1,534	311	1,55,964	1·06	...	...	...
		„ Pegu	...	214	635	2,781	2·9	0·4	207	587	98	75,500	0·64	...	...	...
		„ Yamèthin	...	11$\frac{1}{2}$	5	4,184	3·0	0·5	114	386	137	29,350	0·53	...	...	...
		„ Pyapôn	...	...	12	156	...	...	12	6	5	605	3·32	...	...	...

SPECIAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Spirit Levelling Operations.		Traversing.			Detail Survey.		Record writing.
			Miles levelled over.	Trigonometrical stations connected with.	Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Area in square miles.	Linear miles of test lines.	Number of fields.
...	25	Tidal and Levelling	941(*a*)	3	...	...	...	...	...	...
16	Detachment.	Cantonment Section No. I.	...	...	22	217	2,749	33·4	123·4	...
64		Meerut and Lucknow Divisions	...	...				0·2		
16	„							23·6	86·8	„
64		Cantonment Section No. II. Poona and Mhow Divisions.	...	...	7	133	2,449	0·7	10·8	...
105·6								0·1	0·7	...
105·6	Calcutta Suburbs Survey.	Port Commissioners' area	...	...	2	67	2,876	2·0	...	5,346
32		Salt Lake area in Dhappa	...	...	2	34	300	2·0	...	...
$\frac{1}{2}$	3	Lushai Hills, Chin Hills and Arakan Hill Tracts.	...	...	...	...	...	1 194	„	...

(*a*) Double Levelling.

Statement showing the cost-rate of work executed by the Field Parties during the year 1907-08.

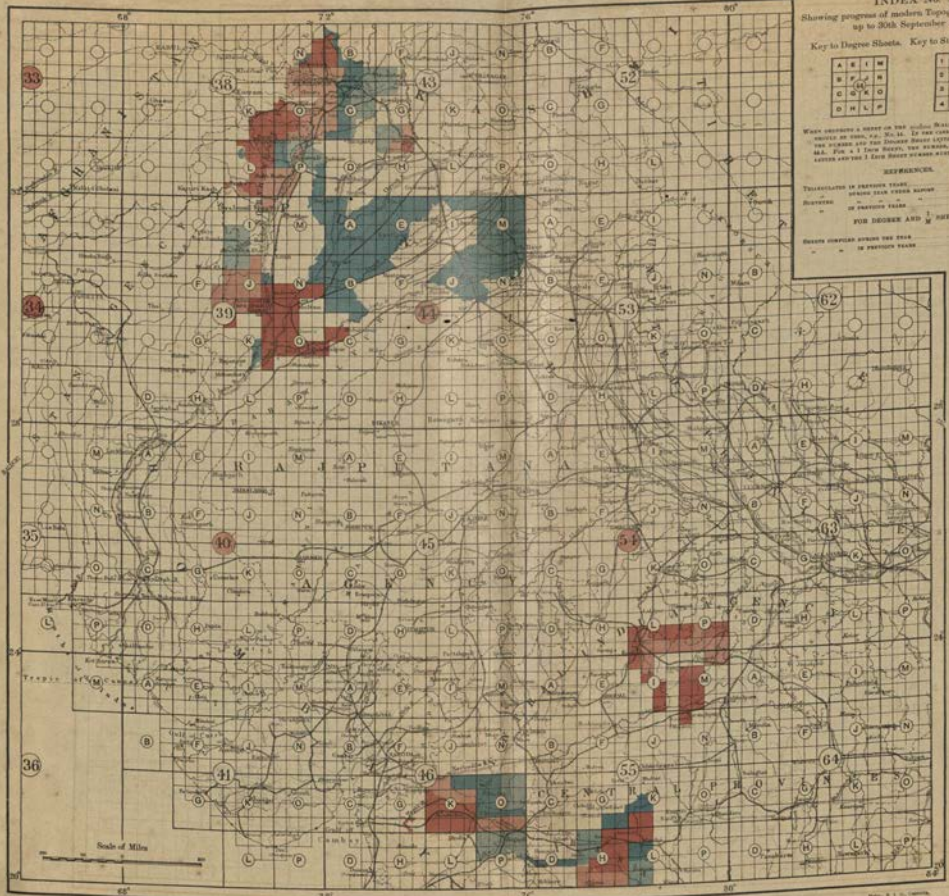
Number of Party.	Name and *locale* of field operations.	Cost-rate per square mile.						Total cost for survey year ending 30th September 1908.
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of				
				1″	1½″	2″	4″	
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹
1	Central and United Provinces and Central India States.	9·9	9·5	12·4 (*b*)	...	17·3 (*a*) 25·4 (*b*)	...	1,01,348
2	Berar	9·3	...	24·4 (*e*) 11·5 (*d*)	...	54·3 (*c*)	16·6 (*c*) (*e*)	95,347
3	Upper Burma	22·3	...	24·1 24·8 (*f*)	...	88·0	...	1,13,490
6	Khulna (Sundarbans)	...	55·8	...	...	42·5	...	
9	Northern Circle	5·7	...	27·5 (*c*) 6·4 (*d*)	...	22·1 (*c*) 6·4 (*d*)	...	85,163
10	Upper Burma	6·5	31·4 (*e*)	34·2 19·9 (*f*) 19·8 (*a*)	...	50·4	56·0	1,33,045
11	Southern Shan States	8·9	...	...	44·9	...	...	1,41,591
12	Northern Circle	11·4	...	...	...	34·8 (*c*) 8·2 (*d*)	...	85,844
14	„ „	7·2	...	...	...	30·5 (*c*) 7·7 (*d*)	...	95,003
17	Bombay Presidency	3·0	...	...	...	18·0 (*a*) 32·7 (*b*)	...	80,556
18	Northern Circle (Dera Ismail Khan).	9·1	7·4 (*e*)	7·4	...	35·0	...	1,24,491
	„ „ Punjab rivers	...	13·1 (*e*)					
	„ „ Bári Doáb	...	26·2 (*e*)					
19	Madras Presidency	3·5	46·8 (*e*)	8·5 6·8 (*a*)	... ...	52·8 5·3 (*a*)	326·0	1,22,816
20	Assam	12·8	20·9	...	...	27·2 28·1 (*a*) 12·3 (*f*)	...	1,18,471
	Northern Circle Training	9·1	...	...	...	45·8	...	41,307

(*a*) Revision Survey.
(*b*) Re-survey.
(*c*) Exclusive of mapping.
(*d*) Mapping charges only.
(*e*) Rate per linear mile.
(*f*) Supplementary Survey.

Cadastral and Cantonment Surveys.

Number of Party.	Nature and scales of field operations.	Cost-rate *per* square mile.						Total cost of party inclusive of charges for instruments for Local Governments.
		Traverse.	Detail survey and preparation of maps on scale of				Completion of vernacular records.	
			12″	16″	8″	6·4″		
	Cadastral surveys.	₹	₹	₹	₹	₹	₹	
4	Monghyr, hill block	40·8	...	...	...	...	...	74,263 (*a*)
	Patna	41·0	...	...	...	...	...	
	Shahabad	37·3	...	...	...	...	...	
5	Midnapore (Jhagran Estate).	33·1	...	...	...	...	...	78,182 (*a*)
	Singhbhum	35·6	...	...	...	...	...	
	Ranchi	34·3	...	...	...	...	...	
	Manbhum (Pargana Baráhabhúm).	41·6	...	...	...	...	...	
6	Jalpaiguri	47·8	...	...	...	...	...	2,82,192
	Mymensingh	56·1	...	...	...	...	...	
	Faridpur	59·1	...	...	...	...	...	
	Dacca	81·9	...	...	...	...	...	
7	Thayetmyo	...	...	104·4	...	...	...	1,57,847
	Pyapôn	...	...	280·2	...	...	...	
	Yamèthin	187·1	...	149·2	...	...	...	
	Pegu	85·7	...	76·6	...	...	...	
Detachment.	Cantonment Section, No. I	0·5 (*b*)	...	1·1 (*c*)	...	7·3 (*c*)	...	26,850
	Cantonment Section, No. II	0·8 (*b*)	...	1·2 (*c*)	...	8·8 (*c*)	...	23,662

(*a*) Includes certain charges for petty surveys.
(*b*) Cost per acre.
(*c*) Cost per acre including mapping.



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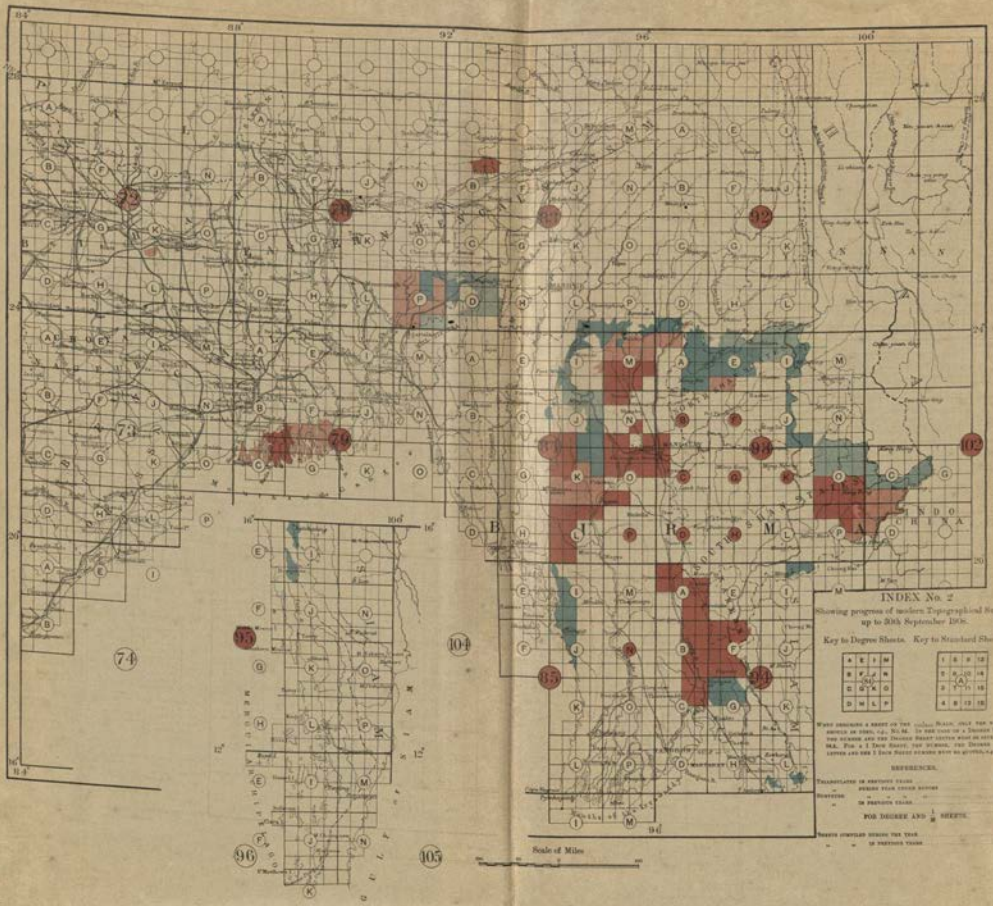
R A J P U T A N A
A G E N C Y
C E N T R A L P R O V I N C E S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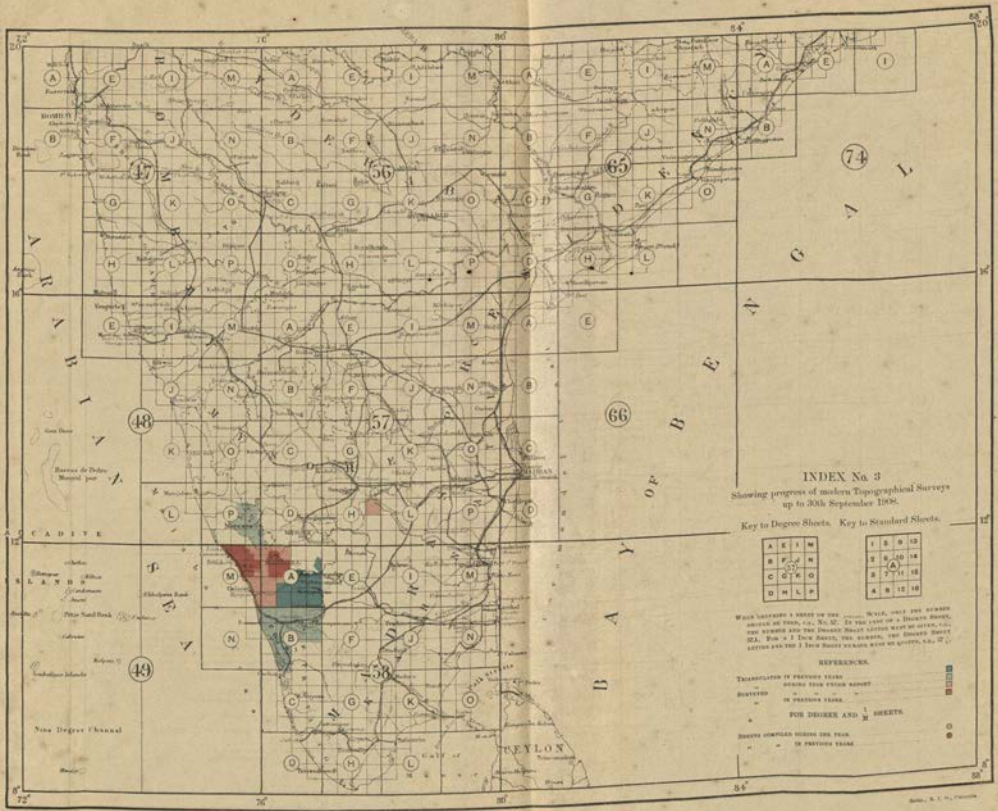
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Pamban Pass
Rameswaram Island
Pamban
Mandapam
Tuticorin
Kilakarai
Kayalpatnam
Vembar
Tiruchendur
Manapad
Kulasekharapatnam
Periapatnam
Kovilpatti
Ettayapuram
Sattur
Virudhupatti
Aruppukkottai
Tiruchuli
Srivilliputtur
Rajapalaiyam
Sivakasi
Sankarankoil
Tenkasi
Shencottah
Courtallam
Tinnevelly
Palamcottah
Nanguneri
Ambasamudram
Kallidaikurichi
Papanasam
Tirukkurungudi
Nanguneri
Kalakkad
Manimuttar
Cheranmahadevi
Kuttalam
Tenmalai
Ramanadhapuram
Mudukulattur
Paramakudi
Kamudi
Tiruppuvanam
Sivaganga
Manamadura
Tirumayam
Alangudi
Kottaippatti
Pudukkottai
Viralimalai
Tiruchirappalli
Srirangam
Musiri
Karur
Kulittalai
Manapparai
Dindigul
Palni
Oddanchatram
Vedasandur
Aravakurichi
Kodaikanal
Periyakulam
Theni
Bodinayakkanur
Uttamapalaiyam
Cumbum
Kambam
Gudalur
Devala
Pandalur
Nilambur
Manjeri
Perinthalmanna
Mannarghat
Palghat
Ottapalam
Pollachi
Udumalaipettai
Dharapuram
Kangayam
Perundurai
Erode
Gobichettipalaiyam
Bhavani
Sathyamangalam
Tiruppur
Coimbatore
Mettupalaiyam
Karamadai
Annur
Avanashi
Palladam
Udumalaipettai
Dharapuram
Kangayam
Perundurai
Erode
Gobichettipalaiyam
Bhavani
Sathyamangalam
Tiruppur
Coimbatore
Mettupalaiyam
Karamadai
Annur
Avanashi
Palladam
Salem
Namakkal
Rasipuram
Tiruchengodu
Sankaridrug
Attur
Yercaud
Omalur
Mettur
Dharmapuri
Krishnagiri
Hosur
Denkanikota
Rayakottai
Tirupattur
Vaniyambadi
Ambur
Gudiyatham
Vellore
Arcot
Ranipet
Walajapet
Sholinghur
Arkonam
Tiruttani
Pallipattu
Tiruvallur
Poonamallee
Madras
Chingleput
Conjeeveram
Uttiramerur
Tindivanam
Gingee
Tirukkoilur
Ulundurpet
Villupuram
Tirukkoilur
Ulundurpet
Villupuram
Cuddalore
Chidambaram
Porto Novo
Sirkali
Mayavaram
Kumbakonam
Tiruvarur
Nannilam
Tiruthuraipundi
Mannargudi
Nidamangalam
Vedaranyam
Point Calimere
Negapatam
Nagore
Karaikal
Tranquebar
Pondicherry
Cuddalore
Chidambaram
Porto Novo
Sirkali
Mayavaram
Kumbakonam
Tiruvarur
Nannilam
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Tiruthuraipundi
Mannargudi
Nidamangalam
Vedaranyam
Point Calimere
Negapatam
Nagore
Karaikal
Tranquebar
Pondicherry

INDIA
PRELIMINARY ISOMAGNETIC CHART
showing
ISOGONALS AND LINES OF EQUAL SECULAR CHANGE
1915
REFERENCES.
Isogonals
Lines of equal secular change
Boundary of Survey
Note 1. The figures against the lines of equal secular change show the amount by which the Declination is increasing or decreasing yearly.
2. These lines are not at present laid down east of Calcutta owing to lack of data.
BENGAL
DIAN OCEAN
SUMATRA

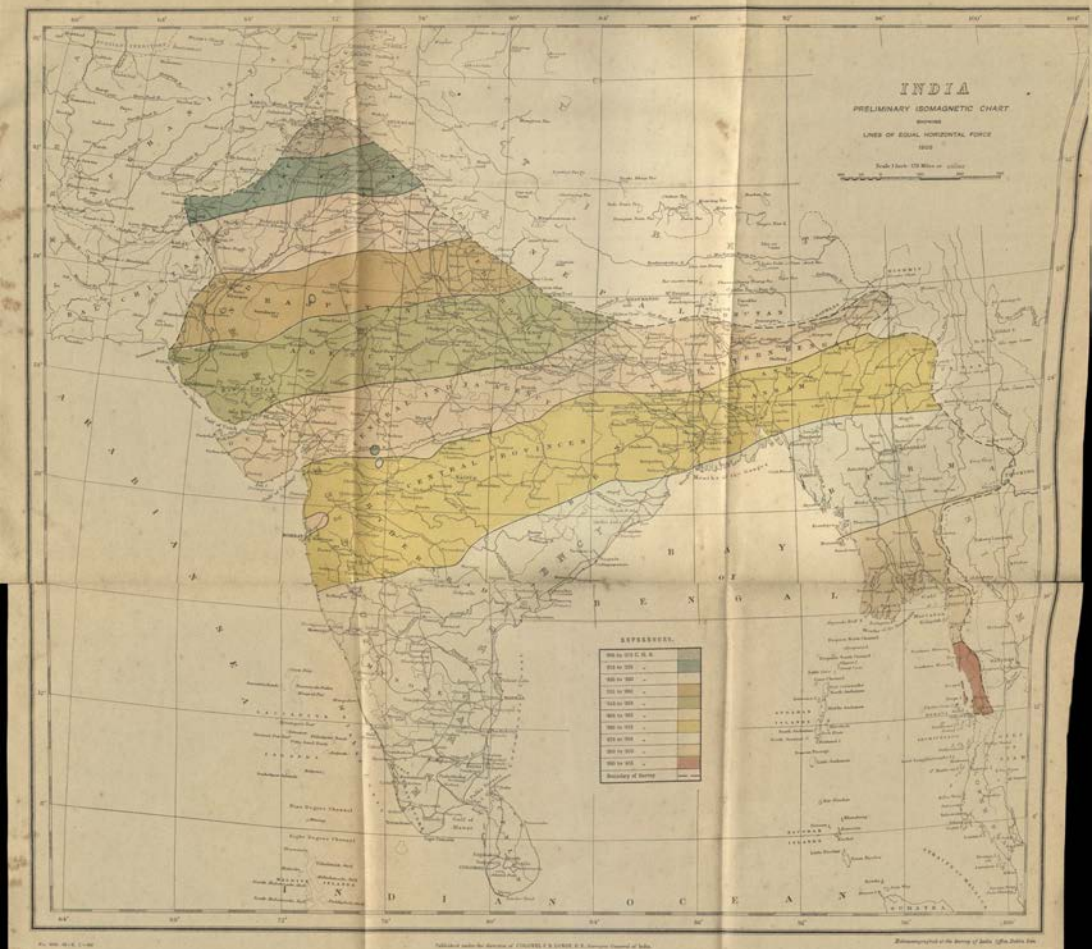
Published under the direction of COLONEL J. E. LUTON R. E. Surveyor-General of India.
March 1915.

Photozincographed at the Survey of India, Office, Dehra Dun.

Published under the Direction of COLONEL S. B. LONGE, R. E., Surveyor General of India.

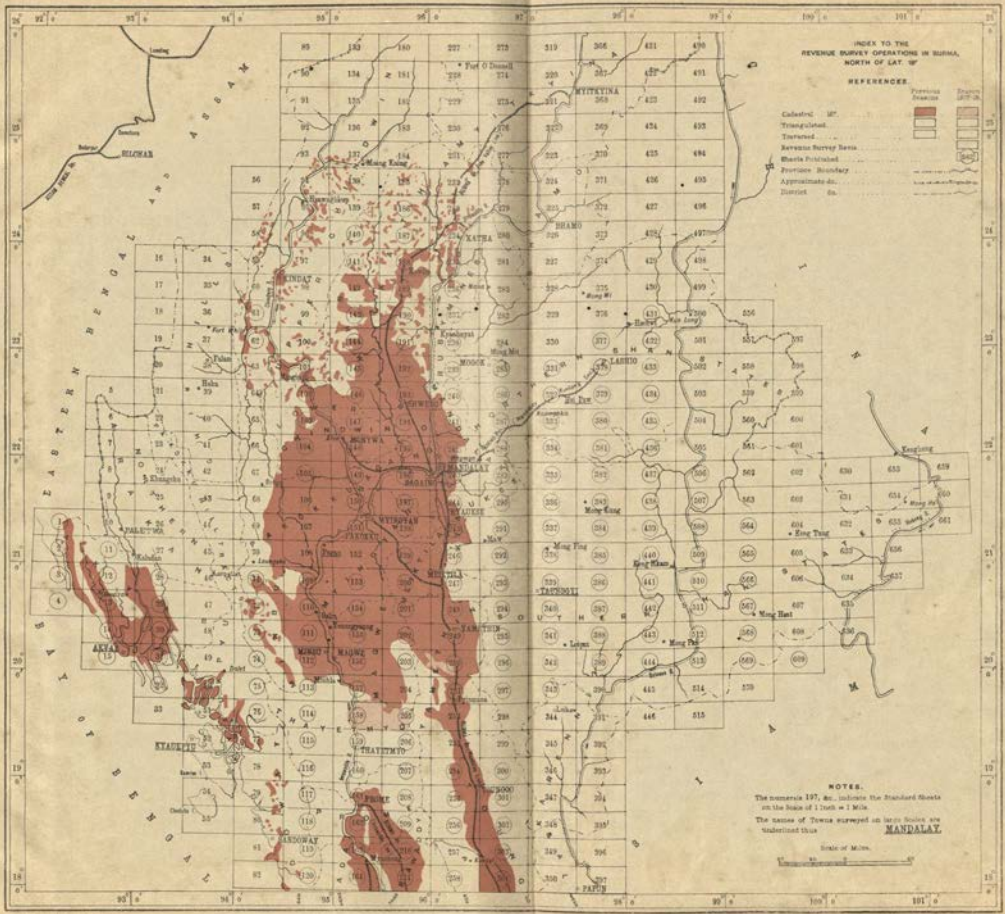
Photozincographed at the Survey of India, Office Dehra Dún.

March 1910


INDIA
PRELIMINARY ISOMAGNETIC CHART
SHOWING
LINES OF EQUAL HORIZONTAL FORCE
1905
Scale 1 Inch=170 Miles or 268km
EXPLANATION.
Boundary of Survey
B A Y O F B E N G A L
I N D I A N O C E A N

Published under the direction of COLONEL S. G. BURRARD R.E. Surveyor General of India.
February 1906.
Photozincographed at the Survey of India Office Dehra Dun.

INDIA
SHEWING THE PROGRESS OF TRIGT SURVEYS
To 1st October 1861
REFERENCE TO COLOURS
Surveyed during previous Seasons
Do. 1861-62
Triangulated & Traversed during previous Seasons
Surveyed during previous Seasons on 1" Scale
BAY OF BENGAL
INDIAN OCEAN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NORTH OF LAT. 18°
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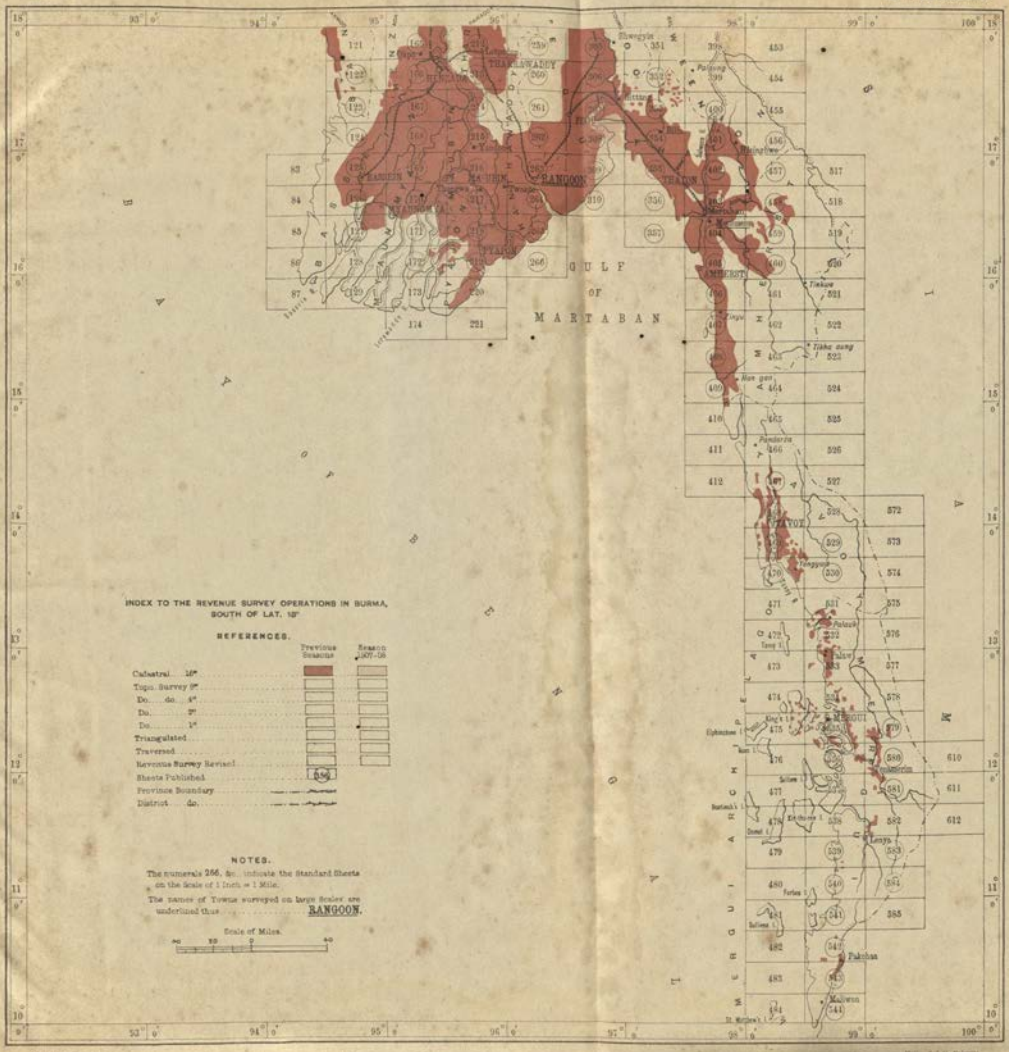
Previous Seasons
Season 1907-08.
Cadastral 16".
Triangulated.
Traversed.
Revenue Survey Basis.
Sheets Published.
Province Boundary.
Approximate do.
District do.
NOTES.
The numerals 197, &c., indicate the Standard Sheets on the Scale of 1 Inch = 1 Mile.
The names of Towns surveyed on large Scales are underlined thus MANDALAY.
Scale of Miles.
BENGAL
ASSAM
EASTERN BENGAL AND ASSAM
SHAN STATES
SOUTH SHAN STATES
BHAMO
MYITKYINA
KATHA
KINDAT
MOGOK
MONYWA
SAGAING
MINBU
PAKOKKU
YENANGYAUNG
MAGWE
MANDALAY
MYINGYAN
PAKOKKU
THAYETMYO
PAKHOKKU
YAMETHIN
MEIKTILA
YEU
TAUNGDWIN
PALEIK
AKYAB
KYAUKPYU
SANDOWAY
PAPUN
LASHIO
Kengtung
Mong Hsat
Mong Pai
Mong Yang
Mong Nai
Mong Mit
Mong Kung
Mong Ping
Mong Tung
Mong Pu
Loilem
Kyaukme
Hsipaw
Thibaw
Bhamo
Myitkyina
Katha
Kindat
Monywa
Sagaing
Mogok
Minbu
Pakokku
Yenangyaung
Meiktila
Yamethin
Mandalay
Myingyan
Thayetmyo
Yeu
Taungdwin
Paleik
Akyab
Kyaukpyu
Sandoway
Papun
Lashio
Kengtung
Mong Hsat
Mong Pai
Loilem
Hsipaw
Thibaw
Bhamo
Myitkyina
Katha
Kindat
Monywa
Sagaing
Mogok
Minbu
Pakokku
Yenangyaung
Meiktila
Yamethin
Mandalay
Myingyan
Thayetmyo
Yeu
Taungdwin
Paleik
Akyab
Kyaukpyu
Sandoway
Papun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Previous Season
Season 1907-08
Cadastral 16"
Topo. Survey 8"
Do. do. 4"
Do. 2"
Do. 1"
Triangulated
Traversed
Revenue Survey Revised
Sheets Published
Province Boundary
District do.
NOTES.
The numerals 256, &c. indicate the Standard Sheets on the scale of 1 Inch = 1 Mile.
The names of Towns surveyed on large Scales are underlined thus RANGOON.
Scale of Miles.
40 20 0 40
GULF OF MARTABAN
ANDAMAN SEA
MERGUI ARCHIPELAGO
RANGOON
THAYETMYO
PEGU
MERGUI
Tavoy
Tenasserim
Victoria Point
Pakchan
Maliwun

Major James Rennell, F.R.S.,

'The first great English Geographer'.

Reproduced from a Medallion in the possession of the Asiatic Society of Bengal.

James Rennell

Born near Chudleigh in Devonshire on the 3rd December 1742. Entered the Navy in 1756 and served with the expedition of the Duke of Marlborough to Brittany in 1758. Volunteered for service in the East Indies and was employed on Marine Surveys till 1764, when he went to Bengal and was appointed Probationer Engineer in Fort William. The Survey of the Delta of the Ganges and Brahmaputra, commenced in the same year under the orders of the Governor, Mr. Vansittart, and subsequently extended under Lord Clive and Warren Hastings to the remainder of Bengal, occupied him till his retirement, owing to ill health, in 1776, with the rank of Major. During the progress of this work he was severely wounded in a skirmish with a band of fanatic rebels, the Sunyasi Fakirs, in Northern Bengal. He was appointed "Surveyor of the East India Company's Dominions in Bengal" by Lord Clive on the 1st January 1767, with a staff of four Assistants :—Capt. Lewis DuGloss, Capt. John Adams, Lieut. Carter, and Ensign William Richards. On his retirement he settled in London, and devoted himself to the study of scientific geography. His chief publications were:—The "Bengal Atlas, containing Maps of the Theatre of War and Commerce on that side of Hindoostan", 1779; "A Memoir of a Map of Hindoostan", 1783; and "The Geography of Herodotus", 1800. He was elected a fellow of the Royal Society in 1781, received the Copley Medal of the Society in 1791, and the Gold Medal of the Royal Society of Literature in 1825. He died at the age of 88 on the 29th March 1830, and was buried in the Nave of Westminister Abbey.

Extract from a note supplied by T. H. D. LaTouche, Esq., Director, Geological Survey of India.

Engraved and printed by, the Survey of India Offices.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

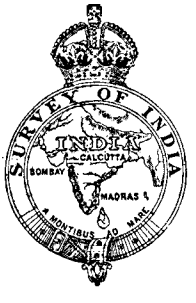
DURING

1908-09

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E., A.D.C.

SURVEYOR GENERAL OF INDIA



CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1910

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BAY OF BENGAL
INDEX CHART
OF THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA.

INDIA
To 1st October 1901
BAY
OF
BENGAL
INDIAN OCEAN

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1908-09.

PART I.

SUMMARY.

ADMINISTRATION.

1. This report deals with the operations of the Survey of India for the year ending the 30th September 1909.

Colonel F. B. Longe, R.E., A.D.C., administered the department throughout the year.

Colonel S. G. Burrard, R.E., F.R.S., continued as Superintendent, Trigonometrical Surveys, except for a short period from 15th August 1909 to the end of the year, when he was deputed to England to represent the Government of India at the triennial conference of the International Geodetic Association, and Captain H. H. Turner, R.E., officiated for him. Colonel G. B. Hodgson, I.A., held the appointment of Deputy Surveyor General up to 20th April 1909, when he proceeded on combined leave and Colonel T. F. B. Renny-Tailyour, R.E., was appointed to officiate in that appointment. The superintendence of the parties working in Bombay, Berár and Central Provinces and the Cantonment sections was under Colonel Hodgson, I.A., up to 11th October, under Lieutenant-Colonel J. M. Fleming, I.A., from 12th October to 16th April and under Colonel Renny-Tailyour, R.E., from 17th April up to the close of the year. The superintendence of the parties working in Southern India, Burma and Assam was under Lieutenant-Colonel P. J. Gordon, I.A., up to 21st October and again from 17th April up to the close of the year, and under Colonel Hodgson, I.A., from 22nd October to 16th April. The post of the Superintendent, Northern Circle, was held by Major C. H. D. Ryder, D.S.O., R.E., up to 6th June and thereafter by Lieutenant-Colonel W. J. Bythell, R.E.

2. In January 1909 a building site comprising 7½ acres of the Langford house estate in the civil and military station of Bangalore was acquired by Government with the view of erecting a building for the accommodation of the party and circle offices of the Southern Circle.

3. Two officers of the Federated Malay States survey were attached to field parties during the field season for instruction in the Indian method of surveying.

4. During the year under report, orders have been received for the formation of the new Provincial Service and the Upper Subordinate Service. The former will consist of 77 posts with salaries commencing at R250 and rising by triennial increments of R50 to R600 with 10 additional posts carrying salaries from R650 to R1,000 to be filled by selection. The latter will consist of 116 posts with a salary of R80 rising by triennial increments of R15 to R200 with 9 additional posts of R250 which will be filled by selection.

Inspection Tours of Administrative Officers.

5. Colonel F. B. Longe, R.E., Surveyor General of India, as previously reported, arrived in India on return from leave, on the 25th September 1908, and proceeded at once to Bangalore on inspection duty. He left Bangalore on October 8th for Mussooree, where he inspected the parties of the Northern Circle and the United Provinces, and Mussooree Drawing offices; from there he proceeded to Simla arriving on the 26th October. At Simla he inspected the Simla Drawing office, and on the 1st November left for Roorkee, arriving the same day. He discussed the question of the future training of soldier-surveyors with Colonel Heath, R.E., Commanding the 1st Prince of Wales' Own Sappers and Miners, who is now entrusted with their preliminary training; also matters connected with the reproduction of maps in the field. He visited the Corps printing establishments. On the 4th November he went to Dehra Dún where he inspected the Trigonometrical Branch office, and the Forest Survey office. He proceeded to Calcutta on the 10th November, and remained there till the 7th March 1909, when he proceeded on tour in Northern India. *En route* he satisfied himself that the maps in the neighbourhood of Lucknow were very much out of date, and deficient in minor details; while those of the country round Delhi, and of the country between Lucknow and Delhi, require careful revision. A party will commence the necessary preliminary work in this area next field season. He arrived at Lahore on the 16th March. After inspecting the riverain detachment of No. 18 Party he decided that its drawing office should remain there throughout the year instead of proceeding to Mussooree. He also inspected the special traverse detachment under Mr. J. de G. Hunter, and visited the Revenue and Settlement Commissioners. The Superintendent, Northern Circle, Major Ryder, D.S.O., R.E., joined him at Lahore on the 19th and together they proceeded, *vid* Pesháwar, Kundián Samásata, Bhátinda, to Simla. As this tour took him through country under survey at the time, he was able to see the actual work in progress, being met at various stations on the line, and at halting places, by the officers and surveyors working in the immediate neighbourhood. He arrived at Simla on the 31st March. His camp office opened there on the 1st April, remaining until the 15th June, when it returned to Calcutta. On the 19th June he left Simla for Mussooree, where he inspected the parties of the Northern Circle. He left Mussooree on the 21st July for Dehra Dún, where he inspected the Trigonometrical Branch office, and the Forest Map office. He left Dehra Dún on the 24th July, and arrived at Poona on the 26th. Here he inspected the parties of the Southern Circle, and having arranged their programme for the coming field season, left for Bangalore on the 1st August.

At Bangalore he presided at the annual conference of administrative officers which commenced on the 4th and concluded on the 14th August. The pamphlet containing instructions for the preparation of maps, published in 1907, was thoroughly gone into and revised, in the light of the experience gained in the last two years. The rules regarding pay, and promotion, of all classes of subordinate and ministerial officers with field parties, other than surveyors, were laid down. The application of the existing travelling allowance rules to subordinate officers was also gone into. It was decided that all triangulation and levelling, in the Northern and Southern Circles, should be handed over to the Trigonometrical Branch, after the close of next field season, but for want of a sufficient number of officers, such work for the Eastern Circle could not be undertaken for some time. The rules regarding the preparation of maps for the Forest Department, and regarding the 4-inch boundary survey, were considered and settled. The selection of surveyors who should be rewarded for past services, and who were worthy of promotion to the Upper Subordinate Service, was made.

During his stay at Bangalore he inspected the Circle office, and all the parties recessing there. On the 1st September he proceeded to Ootacamund and arranged with Mr. Brazier of the Forest Department and Mr. Hatchell of the Madras Survey Department, the programme of work and other matters affecting those departments. He returned to Bangalore on the 7th and left Bangalore the same day for Bombay arriving there on the 9th. On the following day he left for Ráwalpindi where he arrived on the 12th. Next day he left for Murree and from thence he proceeded to Srínagar, where he arrived on the 19th. After a short tour, and several interviews with the local authorities, he was able to

estimate and arrange for the execution of the more urgent surveys. Leaving Kashmir on the 24th, he arrived in Calcutta on the 31st October. *En route*, he inspected the field office of No. 14 Party at Ráwalpindi.

6. Colonel S. G. Burrard, R.E., F.R.S., Superintendent, Trigonometrical Surveys, visited Mussooree during May and June 1909, and inspected the recess offices of Nos. 22, 23, 24 and 26 Parties and the levelling detachment of No. 25 Party. He also inspected at Dehra Dún in May 1909, the Forest Map office and No. 25 Party and the Survey Training School, from time to time during the year.

7. Colonel G. B. Hodgson, I.A., Deputy Surveyor General, inspected the Coorg detachment at Mercara in December 1908, and Nos. 3 and 10 Parties in Burma during January 1909.

8. During January 1909, Lieutenant-Colonel J. M. Fleming, I.A., inspected in the field Nos. 1, 2, and 17 Parties and on several occasions inspected the office of No. 1 Cantonment section at Dum Dum. During recess, Colonel T. F. B. Renny-Tailyour, R.E., officiating Deputy Surveyor General, inspected the above parties in recess, and also visited No. 2 Cantonment section at Secunderábád on his return from attending the departmental conference of Superintendents at Bangalore during July. He also inspected on several occasions the office of No. 1 section at Dum Dum.

9. Lieutenant-Colonel P. J. Gordon, I.A., Superintendent in charge Burma Surveys, made a short tour in South Canara and Cochin in May 1909. On the 8th September 1909 he proceeded to Burma where he inspected Nos. 10 and 11 Parties in recess at Maymyo and returned to Bangalore *vid* Calcutta on the 5th October 1909.

10. Major C. H. D. Ryder, D.S.O., R.E., Superintendent, Northern Circle, was at Simla from the 1st to the 7th October 1908 inspecting the Simla Drawing office. He returned to Mussooree on the 9th October. On the 3rd December he left Mussooree, arriving at Leiah on the 5th to inspect No. 9 Party, reaching Dera Ismail Khán on the 11th where he inspected No. 18 Party, and then proceeded to Basal to inspect No. 14 Party. He inspected No. 12 Party at Abbottábád and Pesháwar and the riverain detachment of No. 18 Party at Lahore, returning to Mussooree on the 24th December 1908. He left Mussooree in February 1909 and inspected the Bári Doáb traverse section of No. 18 Party at Multán on the 17th February and after inspecting No. 9 Party at Kot Sultán, and No. 18 Party at Miánwáli, he arrived at Pesháwar on the 25th, where he inspected No. 12 Party. He then proceeded to Ráwalpindi to inspect No. 14 Party and returned to Mussooree on the 4th March 1909. He again left Mussooree on the 18th March, meeting the Surveyor General and accompanying him on his tour through the Punjab, in the course of which Nos. 9, 12, 14 and 18 Parties were visited, and after an inspection of the Simla Drawing office, he returned to Mussooree on the 6th April. On the 7th June he handed over the office of the Superintendent, Northern Circle, to Lieutenant-Colonel W. J. Bythell, R.E., on the return of the latter from furlough, and took over charge of No. 14 Party from Lieutenant Trenchard, R.E., on the 15th June.

11. Lieutenant-Colonel W. J. Bythell, R.E., proceeded to Bangalore on the 30th July 1909 to attend the survey conference and returned to Mussooree on the 20th August. He proceeded to Simla on the 8th September to inspect the Simla Drawing office, returning to Mussooree on the 13th September. He inspected all the recess offices of the parties under his administrative control between the 7th June and the 30th September, besides visiting them frequently.

DISTRIBUTION OF FIELD PARTIES.

12. Field operations were carried out by 17 parties and 3 sections or detachments. Of the parties, 12 were employed on topographical surveys, 1 on principal triangulation, and 4 on purely scientific operations. A new detachment was formed on the 1st November 1908 for the purpose of commencing survey operations in Coorg. No. 7 Party (Burma Cadastral) having completed the work assigned to it was disbanded in December 1908. The following table

shows the distribution according to the nature of the work on which the parties were employed:—

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale.	Administrative Superintendent.
	TRIGONOMETRICAL.				
24	India	27	Captain C. M. Browne, D.S.O., R.E.	...	S. T. S.
	SCIENTIFIC.				
22	India (Latitudes) . .	31	Captain H. McC. Cowie, R.E. . Lieutenant H. J. Couchman, R.E.	...	S. T. S.
23	„ (Pendulums) . .	31	Captain H. McC. Cowie, R.E. .	...	Ditto.
25	„ (Tidal and Levelling).	33	Mr. C. F. Erskine . . .	...	Ditto.
26	„ (Magnetic) . .	36	Captain R. H. Thomas, R.E. .	...	Ditto.
	TOPOGRAPHICAL.				
9	Northern Circle . .	42	Captain G. A. Beazeley, R.E. . Lieutenant E. C. Baker, R.E. .	1″=1 M.	Supdt., Northern Circle.
12	„ „ . .	43	Brevet-Major E. T. Rich, R.E. . Lieutenant E. C. Baker, R.E. .	2″=1 M. 1″=1 M.	Ditto.
14	„ „ . .	44	Major C. H. D. Ryder, D.S.O., R.E. Lieutenant O. H. B. Trenchard, R.E.	2″=1 M.	Ditto.
18	„ „ . .	45	Captain E. A. Tandy, R.E. . Captain L. C. Thuillier, I.A. .	2″=1 M. 1″=1 M.	Ditto.
1	Central Provinces and Central India Agency.	47	Major C. L. Robertson, C.M.G., R.E. Lieutenant M. N. MacLeod, R.E. Lieutenant K. W. Pye, R.E. .	2″=1 M. 1″=1 M.	Supdt., Southern Circle, (D. S. G.)
2	Central Provinces and Berár.	49	Captain H. Wood, R.E. . .	2″=1 M. 1″=1 M.	Ditto.
17	Bombay Presidency, Central India Agency and Hyderábád.	50	Lieutenant S. W. S. Hamilton, R.E.	2″=1 M. 1″=1 M.	Ditto.
19	Madras . . .	53	Major C. W. H. Symonds, I.A.	2″=1 M.	Supdt., Burma Surveys.
...	Coorg Detachment .	54	Mr. R. Waller-Senior . .	2″=1 M.	Ditto.
3	Burma . . .	55	Captain C. P. Gunter, R.E. .	2″=1 M. 1″=1 M.	Ditto.
10	„ . . .	56	Captain A. A. McHarg, R.E. . Captain L. G. Crosthwait, I.A.	2″=1 M. 1″=1 M.	Ditto.
11	Shan States . . .	58	Captain R. H. Phillimore, R.E.	1″=1 M.	Ditto.
20	Eastern Bengal and Assam.	59	Major A. Mears, I.A. . .	2″=1 M. 1″=1 M.	Ditto.
Section No.	CANTONMENT SURVEYS.				
1	Punjab, Bengal, United Provinces and Assam.	60	Mr. E. G. Little . . .	64″=1 M. 16″=1 M.	Supdt., Southern Circle, (D. S. G.)
2	Central Provinces, Hyderábád and Burma.	61	Mr. L. J. Pocock . . .	105·6″=1 M. 16″=1 M.	Ditto.

TRIGONOMETRICAL SURVEYS.

13. The triangulation party (No. 24) was divided into 5 principal and 4 secondary detachments of which 1 principal detachment worked in Baluchistán, 1 in the North-West Frontier Province, 2 principal and 2 secondary in Burma, 1 principal in Kashmir, 1 secondary in Assam, and 1 secondary in the Punjab.

Principal Triangulation.

(*a*) In Baluchistán during the summer of 1908 the North Baluchistán series was carried northward from its initial side (Zawa-Zibra of the Kalát longitudinal series) up to latitude 31°, a length of 100 miles. Eight triangles were completed covering an area of 3,500 square miles, the average triangular error being 0·41″.

(*b*) In the North-West Frontier Province the North Baluchistán series was commenced from the starting from the side Bani-Sakesar of the Great Indus series; a length of 50 miles was completed; the seven triangles enclose an area of 1,900 square miles, the average triangular error being 0·602″.

(*c*) In Burma (Shan States) the Great Salween series was continued eastwards to longitude 99° 24′, a length of new series of 100 miles; nine triangles were completed covering an area of 4,200 square miles, the average triangular error was 0·47″.

(*d*) In Upper Burma the selection and building of stations for the Upper Irrawaddy series was carried northward from the side Song-Tangte of the Great Salween series as far as latitude 25° 30′.

(*e*) In Kashmir the new series was commenced from the side Nehr-Khagriani of the North-Western Himalaya series and the work is still in progress.

Secondary Triangulation.

(*f*) In the Punjab a traverse was run with the Jäderin apparatus from Burála T. S. of the Jogí Tilá series to Shorkot h. s., and to Doráwálá s., a total length of about 118 miles.

(*g*) In Assam the selection and building of stations for the Khási hills secondary series along parallel 25° 49′ was commenced.

(*h*) In Lower Burma the selection and building of stations for the Mawkmai secondary series was carried from the side Letpataung-Suletaung of the Mandalay meridional series eastwards along the parallel of 19° 30′ up to longitude 98° 15′.

(*i*) In Upper Burma the selection and building of the stations for a secondary series along the meridian of 97° 0′ was carried northwards from the side Tangte-Taungkalat of the Great Salween series up to latitude 24° 30′.

SCIENTIFIC AND SPECIAL OPERATIONS.

14. On the return of the Standard Bar A from France it was carefully compared at Dehra Dún against the secondary standards I_B and I_S by Captain Turner and Captain Cowie. The comparisons showed that no appreciable change in length had occurred during its journeys from India to Europe and back.

15. Captain Cowie took pendulum observations at twelve stations in Central India with the object of investigating the structure of the Vindhya and Sátpura ranges.

16. The new tidal observatory at Moulmein was opened, and satisfactory observations were obtained. Tidal operations were continued at the eight permanent stations. Levelling operations were carried out by three separate detachments. Three important main lines of levelling were completed, *viz.*:—from Ferozepore to Ahmadábád, from Katni to Nágpur, from Wardhá to Secunderábád. Twenty-six new standard bench-marks were connected.

17. With the completion of observations along the coast of Burma, the preliminary magnetic survey was finished with the exception of the Himalayan-Karakoram regions: the detail survey was commenced by the examination of three obviously disturbed localities.

The reduction of the preliminary survey is in hand; in connection therewith several questions are still under investigation.

18. The following statement shows the cost of the more purely scientific work of the department for the survey year under report:—

						₹
Field Parties, No. 22 Party,				Astronomical		7,440
,, ,, ,, 23 ,,				Pendulums		27,423
,, ,, ,, 24 ,,				Triangulation		2,13,122
,, ,, ,, 25 ,,				Tidal and Levelling:—		
					₹	
				Tidal observations	15,278	
				Preparation of Tide Tables.	26,672	
				Levelling operations	53,620	
						95,570
,, ,, ,, 26 ,,				Magnetic:—		
				Magnetic observatories.	14,841	
				Magnetic field work	59,146	
						73,987
				TOTAL		4,17,542
Controlling and Administrative Staff Trigonometrical					57,772	
Trigonometrical Branch Office					1,37,392	
						1,95,164
				GRAND TOTAL		6,12,706
Last year the cost of the field parties was						4,13,283
Controlling and Administrative staff						63,569
Trigonometrical Branch Office						1,59,874
				GRAND TOTAL		6,36,726

19. Surveyor Pertab Singh of No. 3 Party accompanied an expedition under Lieutenant-Colonel Lumsden, C.B., into the Mishmi country in the beginning of 1909, and surveyed an area of 250 square miles of hitherto unmapped country on the ¼-inch scale.

TOPOGRAPHICAL SURVEYS.

20. *Central Provinces and Central India Agency.*—No. 1 Party continued to carry out supplementary survey, for the most part, on the 2-inch scale, of the area previously cadastrally surveyed in the Central Provinces. An area of 1,716 square miles was thus revised and contoured, in addition to an area of 951 square miles which was done on the 1-inch scale. A further area of 477 square miles was resurveyed, mainly on the 1-inch scale, in the Central India Agency. An area of 3,099 square miles was also triangulated in advance.

21. *Central Provinces and Berár.*—No. 2 Party constituted as an ordinary topographical instead of an instructional party as in previous years, continued the topographical survey of Berár, and extended operations into the Wardhá district of the Central Provinces. An area of 2,448 square miles was surveyed on the 1-inch scale, while 240 square miles, mainly forest area, was surveyed on the 2-inch scale. An area of 2,229 square miles was triangulated in advance. The boundaries of all A and B class forest reserves falling within the area surveyed, aggregating 461 linear miles, were surveyed on the 4-inch scale for the Forest Department.

22. *Bombay Presidency, Central India Agency and Hyderábád.*—No. 17 Party revised and contoured on the 1-inch scale an area of 2,985 square miles, falling mainly in the Central India Agency. In addition, an area of 603 square miles, consisting generally of reserved forests in the East and West Khándesh districts, was mapped on the 2-inch scale, while 205 linear miles of forest boundaries in the same districts were surveyed for the Forest Department on the 4-inch scale. 2,100 square miles were triangulated in advance, mainly in the Hyderábád State.

23. *Eastern Bengal and Assam.*—No. 20 Party triangulated 680 square miles and surveyed 1,512 square miles on the 2-inch and 521 square miles on

the 1-inch scale in the Sylhet and Cáchár districts and in the Hill Tippera State. 119 linear miles were also traversed for topographical purposes.

24. *Coorg.*—A detachment was formed in November 1908 and surveyed 558 square miles on the 2-inch scale in Coorg. An area of 2,565 square miles in Coorg and the South Canara and Malabar districts was also triangulated.

25. *Burma.*—Nos. 3, 10 and 11 Parties continued surveying on the 1-inch and 2-inch scales in the Pakôkku, Upper and Lower Chindwin, Ruby Mines and Bhamo districts and in the Shan States. An area of 9,509 square miles was surveyed, 330 being on the 2-inch scale and 9,179 on the 1-inch scale. An area of 2,906 square miles was also triangulated.

26. *Madras Presidency.*—No. 19 Party triangulated 5,850 square miles in Travancore State and surveyed 1,483 square miles on the 1-inch and 1,065 on the 2-inch scale in Mysore State and in the Nílgiri, Malabar and Coimbatore districts.

27. *Northern Circle.*—No. 9 Party triangulated 309 square miles, traversed 52 linear miles and levelled 115 linear miles. It surveyed 4,598 square miles, of which 285 were revision survey on the 1-inch scale in the Dera Ismail Khán and Dera Gházi Khán districts.

No. 12 Party carried out no triangulation during the year under report, as its programme of detail survey for the following season is based entirely on traverses. It surveyed 1,359 square miles on the 2-inch scale and 953 square miles on the 1-inch scale in the Hazára and Attock districts.

No. 14 Party triangulated 750 square miles for the 2-inch scale and 3,760 square miles for the 1-inch scale in the Ráwalpindi district and Kashmir, and surveyed 2,830 square miles on the 2-inch scale in the Attock, Ráwalpindi and Hazára districts.

No. 18 Party triangulated 1,800 square miles in the Miánwáli, Sháhpur and Attock districts and surveyed 945 square miles on the 2-inch scale and 1,500 square miles on the 1-inch scale in the Dera Ismail Khán and Miánwáli districts. It also traversed 420 linear miles for topographical survey in the Dera Ismail Khán, Miánwáli and Sháhpur districts, 1,827 linear miles in the Bári Doáb completing that work, and 395 linear miles for the riverain work.

FOREST SURVEYS.

28. The forest survey operations of the year were carried out, in nearly every case, by the various topographical parties in whose sphere of operations the forests lay. The surveys were for the most part on the 2-inch scale, but a few small areas were done on the 4-inch scale, and boundary surveys on the 4-inch scale were carried on over a considerable area. The revision of a small area previously surveyed on the 4-inch scale by the Forest Survey Branch was also effected.

29. *Central Provinces (Berár Circle).*—In the course of the 1-inch topographical survey of Berár, No. 2 Party surveyed on the 2-inch scale all the A and B class forests falling in the area under survey in the districts of Akola and Yeotmál, and their boundaries were traversed on the 4-inch scale. The area surveyed on the 2-inch scale amounted to about 160 square miles, and the boundary traversing to 461 linear miles.

30. *Northern Circle.*—No. 12 Party surveyed the Manakrai reserve, and parts of the Tanglai and Lachi Khán reserves in the Hazára district, on the 1-inch scale. The total area amounted to 8 square miles. In addition to this, 4-inch forest surveys previously done by the Forest Survey Branch in a part of the Masar reserve, the Batrasi and Tandiani reserves, and parts of Dunga Gali and Samundar reserves, Hazára division, were revised on the small scale, new details inserted, all the roads classified, and perennial water shown. The total area thus revised on the 4-inch scale amounted to 70 square miles. Part of the Gianthal reserve, in Ráwalpindi district, amounting to 0·80 square mile, was also surveyed on the 1-inch scale by No. 12 Party.

31. *Burma.*—Two parties surveyed forest areas in Burma in the course of their regular operations. No. 3 Party completed 39 square miles on the 2-inch scale in the Myittha and Lower Chindwin divisions, and No. 10 Party surveyed 152 square miles on the same scale in the Bhamo, Mu and Upper Chindwin divisions. The reserves surveyed by No. 3 Party were the Mahamyaing extension, Myittha division, and Thingadôn extension, Lower Chindwin division; and by No. 10 Party, the Simaw, Munsin, Nanhan, Mohlaing, Mainghein, and

Punraung reserves, Bhamo division; the Nanbyan, Nangyitha and Maingwun reserves, Mu division, and Kanti reserve, Upper Chindwin division. As these surveys were conducted in the course of the regular topographical survey, their cost will be borne by the Survey of India. As arranged last year, No. 10 Party surveyed the Mosit reserve in the Bhamo division, area 106 square miles, on the 2-inch scale, in advance of its programme. This being a special survey, its cost will be borne by the Forest Department. Next season only a small area of some 12 square miles is proposed for survey.

32. *Eastern Bengal and Assam.*—Parts of Sonai, Inner Line and Katakhal reserves, in the Cáchár division, Eastern Circle, comprising an area of 367 square miles, were surveyed on the 2-inch scale by No. 20 Party. Owing to the difficult nature of the ground, the early rains, and the presence of a man-eating tiger, the programme of the party was not completed. The work will be completed next season, when parts of the Sonai, Inner Line, Katakhal, Barali, Langai and Singlá reserves will be surveyed.

Madras Presidency.—Forest surveys on the 2-inch scale were carried on during the year by No. 19 Party in the following divisions :—In South Malabar, Attapádi blocks 1, 3 and 4, Erambadam, Nellikkutt, Old and New Amarapalam, Silent valley and Karunipoya reserves, and parts of Attápadi blocks 2, 5 and 6, aggregating 201 square miles. The unsurveyed portions of the last three blocks will be completed next season. The traversing of the Silent valley reserve boundary was completed, and the remainder of the New Amarapalam reserve boundary was traversed as far as possible. In the Nílgiris, 209 reserved forests, of the total area of 357 square miles, were surveyed. Thirty-seven reserves were partially surveyed but the area is so small that it was thought better to report the total area of each on completion. In North Coimbatore, the Akkur reserve, area 2 square miles, and in Central Coimbatore, the Nellimalai reserve, area 3 square miles, were surveyed. These two reserves have been afforested since the 4-inch survey was carried out. The total forest area thus surveyed in the Madras Presidency is 563 square miles, and the whole cost is debitable to the Survey of India.

33. *Bombay Presidency.*—An area of about 394 square miles of forest, falling within Shirpur taluk, of the Western Khándesh district, and Chopda and Yával taluks, of the Eastern Khándesh district, was surveyed on the 2-inch scale by No. 17 Party. The boundaries of these areas, about 205 linear miles, were surveyed on the 4-inch scale. The area is a part of the Sátpura reserves, and is a continuation of the work commenced in 1906.

34. *Coorg.*—In Coorg an area of 56 square miles of forest, comprising parts of the Attur, Dubare, Yedavanad, Devamachi, Mawkal, and Mercara reserves, and the whole of the Anekadu reserve, was surveyed on the 2-inch scale. It is hoped that the Coorg survey will be completed during 1909-10.

CANTONMENT SURVEYS.

35. The survey of Cantonments was continued by the same two detachments as last year. The surveys were as formerly carried out on the 16-inch scale, with bazaars on the 64-inch scale. An exception was, however, made in the case of the bazaars of Secunderábád and Bolárum, the survey of which was the main task of one section throughout the year; for these the large scale of 1-inch =50 feet or 105·6 inches=one mile was employed. Besides the above, the survey of seventeen Cantonments, including the 7 Gallies, was completed. Added portions of four more were surveyed, and preliminary traversing of four other Cantonments in India and Burma was also commenced.

RESULTS.

36. The total outturn of detail topographical and forest surveys on all scales is 42,600 square miles against 35,968 of the previous year. No surveys on a scale smaller than 1-inch=1 mile were carried out during the year except the small area of 250 square miles mentioned under special operations, in the Mishmi country. The total area triangulated for topographical surveys

	Sq. miles.
4-inch scale	70
2 „ „	13,999
1 „ „	28,531
TOTAL	42,600

is 35,550 square miles against 37,396 for the previous year. The area of the maps compiled in standard sheet form for publication on the 1-inch scale by the United Provinces and Bengal drawing offices amounted to 10,042 square miles. Adding this 10,042 square miles to the area surveyed we get a total outturn of mapping on the 1-inch scale of 52,642 square miles and this is a very considerable improvement on the outturn of previous years but the area compiled still requires to be examined in the field and these maps are being published as a preliminary edition.

HEAD-QUARTERS OFFICE, CALCUTTA.

37. The general superintendence of these offices remained in the hands of Colonel F. B. Longe. R.E., Surveyor General, throughout the year.

Major J. M. Burn, R.E., held charge of the Surveyor General's office from the 1st October 1908 to the 10th January 1909 when he was relieved by Colonel T. F. B. Renny-Tailyour, R.E., who remained in charge of it till the end of the year.

Colonel J. M. Fleming, I.A., held charge of the Map Publication offices up to the 11th October 1908 when he was relieved by Major W. M. Coldstream, R.E., who continued in charge throughout the remainder of the year.

Major J. M. Burn, R.E., held charge of the Mathematical Instrument office from the 1st October 1908 to the 10th January 1909 and again from the 21st April 1909 to the close of the year. From the 11th January to the 20th April inclusive the office was under the supervision of Colonel T. F. B. Renny-Tailyour, R.E.

38. *Map Publication Office.*—Major W. M. Coldstream, R.E., continued to act as Superintendent of Map Publication during the year. The charge of the Drawing, Engraving and Map Record and Issue offices was held by Lieutenant A. A. Chase, R.E., up to the 17th December 1908 and from that date till the 7th April 1909 by Lieutenant G. F. T. Oakes, R.E., and for the remainder of the year by Captain M. O'C. Tandy, R.E., Lieutenant V. R. Cotter, I.A., held charge of the Photo.-Litho. office until the 2nd of January 1909, Lieutenant G. F. T. Oakes, R.E., held charge from that date up to the 23rd June 1909 when he handed over to Lieutenant O. H. B. Trenchard, R.E., who remained in charge to the close of the year.

39. This is the first year in which the reorganisation of the publication offices could be fully tested by results, and these are even more satisfactory than were at first anticipated. For the first time since the inception of the new surveys, the publication of standard sheets has kept pace with the survey and drawing. Between 1st October 1908 and 30th September 1909, 175 new standard sheets were received for publication, while 195 sheets were printed, and a considerably larger number could have been printed, had more sheets been received sufficiently early in the year.

If a few standard sheets which have been returned to the field parties for further information and which have not yet been re-submitted, are excluded, only 3 of the sheets received at head-quarters before October 1st, 1908, have not been printed and the publication of these 3 sheets has been delayed solely on account of references in connection with boundaries, etc., and not on account of delays or difficulties in the publication offices. The increase in labour and the difficulties involved in the new system of publishing sheets half the size of the old maps, in black and 4 colours, were described in some detail in last year's report, and it is satisfactory to be able to report this year that they have been met successfully. In quality also as well as in quantity this year's results have been satisfactory and a steady improvement in the quality of the reproduction has been maintained. The Topographical maps of the United Kingdom and of some foreign countries which are reproduced by better but more expensive methods, are superior to the Indian standard sheets in finish, but there is probably no other country which has so large an annual outturn of new maps of this class to produce as India, and for India to adopt the more expensive methods would necessitate an expenditure not warranted by the very small demand that can be expected for quite 80 per cent. of the Indian sheets. Since its reorganisation was begun in 1906 the Photo.-Litho. office has already printed new standard sheets representing a combined area greater than that of England, but a glance

at the index map indicating the state of map publication will show that as yet only a small fraction of the work to be done has been dealt with.

40. In addition to the new 1-inch standard sheets 126 of the old 1-inch standard sheets covering areas for which new material is not yet available have been reprinted during the year to replenish stock. The number of the old sheets which are out of print is still large. Some of them are, however, so incomplete and out of date that pending new surveys they are not worth the expense of reprinting.

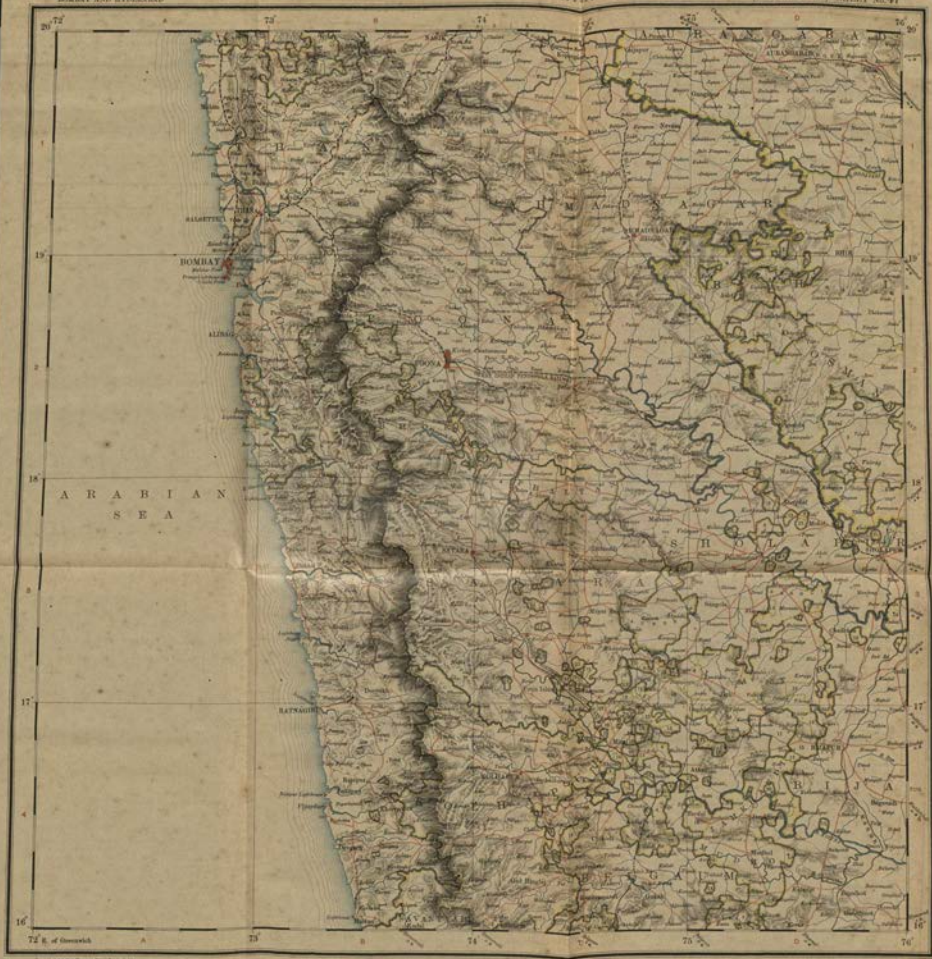
41. New material for some 10 degree sheets is now available and 7 are under preparation in the various Circle drawing offices. An important simplification in the method of preparing these and other maps to be compiled from the new surveys has been effected by an arrangement made in the Photo.-Litho. office to supply, on one sheet of drawing paper, complete combined reductions of the 16 component standard sheets which form a degree sheet, on a scale of $2\frac{2}{3}$ miles=1 inch. These reductions are printed in cobalt and the detail to appear in the $\frac{1}{4}$-inch map is selected and fair drawn in black over the blue detail. The map is then completed by the addition of the lettering, etc., in the ordinary way, and reduced by photography to its correct dimensions on the scale of 1 inch=4 miles. The degree sheets will be printed in the same colours as the standard sheets, the plates for each colour being obtained from different negatives of the outline map by "duffing" in exactly the same way as with standard sheets. The hill features will be shown by brush or stump shading printed in half-tone and possibly supplemented by approximate contours at 500 feet intervals. A good deal of experimental work has been done during the year in the direction of obtaining artistic results in half-tone shading that will retain scientific accuracy. The chief difficulty lies in the preparation of the original shaded drawings, as the number of draftsmen who can yet do work of this description is very limited. The difficulty is, however, being overcome as the men acquire the requisite skill, and some very fair results have also been obtained from drawings executed in stump shading which is a more easily acquired art than brush shading. Another difficulty caused by the reproduction of the blue detail over which the shading is executed has been almost entirely removed by the substitution of blue prints prepared by the "dust on" process, for ordinary blue prints. The office is indebted to Mr. R. Taylor for the invention of the "dust on" process.

The method by which the shading is reproduced by half-tone photography was alluded to in paragraph 55 of the summary of the Annual Report for 1905-06, and in paragraph 66 of the summary of the Annual Report for 1906-07. It also is the invention of Mr. R. Taylor, the head of the photo. branch of the Photo.-Litho. office and has been communicated to the Ordnance Survey at Southampton where it is believed to be now in use. The process consists in printing a sensitised plate from two negatives superimposed in the printing frame. The light is thrown on the printing frame from a large mirror so arranged that the rays fall perpendicularly on the negatives. One of the negatives, a plain or continuous tone negative, is underexposed and developed so that the high lights are as soft and even as possible, the other is an ordinary half-tone negative taken through a ruled screen.

42. While material is rapidly becoming available for the preparation of degree sheets, it will be some years yet before the new surveys yield material for new maps of the $\frac{1}{\text{million}}$ or "India and adjacent countries" series. Each $\frac{1}{\text{million}}$ sheet includes 16 degree sheets and 256 standard sheets. In the meantime, as stated in the last year's report, provisional editions of the $\frac{1}{\text{million}}$ sheets prepared from the most reliable information available are being brought out. The progress on this work during the year has been real, though the published results are very meagre. The maps of this series already published leave much to be desired and are to some extent experimental. Captain M. O'C. Tandy, R.E., the officer in charge of the head-quarters drawing office, has devoted much of his time to improving the $\frac{1}{\text{million}}$ sheets, and although some minor points have yet to be settled and a good deal of redrawing has had to be faced (to this the small outturn of the year is due), it is believed that a great improvement both in quality and outturn will be reported next year, and by the time new material is

INDIA AND ADJACENT COUNTRIES.

(Provisional Issue) SHEET No. 47



available, the department will be in a position to deal with it efficiently and expeditiously. The standard maps as the first results of survey and as the eventual basis of all other departmental maps must remain the most important work of the department, but the degree and $\frac{1}{\text{million}}$ sheets, which are the tactical and strategical maps of the country, are only second to them in importance.

As a sample of the form in which it is intended that these provisional maps should eventually appear, a specimen of sheet 47 of the $\frac{1}{\text{million}}$ series is given here.

43. The six general maps of India maintained by the department are as follows:—

1. India and adjacent countries on the scale of 32 miles = 1 inch.
2. " " " " " 64 " = 1 "
3. India on the scale of . . . . 80 " = 1 " (as a railway map).
4. India and adjacent countries on the scale of 96 " = 1 "
5. " " " " " 192 " = 1 "
6. " " " " " 256 " = 1 "

In addition to these the 128-mile map is still maintained for departmental purposes.

An edition of 1,000 copies of the 32-mile map has been printed in the colouring prescribed by the Government of India for the various Provinces and States and their boundaries. This is the largest coloured map that the department has yet undertaken and 6 to 8 colour plates have been used for each of the 6 sheets. The result is satisfactory although there are some minor defects, due to the inexperience of the offices in this class of the work, which will be avoided in future. The compilation for the new engraved 32-mile map in 12 plates has been completed and an original drawing for the hills, to be reproduced in half-tone, is practically completed for one sheet. The rough estimate given in last year's report for the publication of the outline map some time in 1911 will, it is believed, be found correct.

Preliminary work for a new edition of the 64-mile map is in progress, and it is proposed to bring out a fully coloured edition of the existing 64-mile map in 1909-10.

The 80-mile railway map has been brought up to date and published for the Railway Board and a new railway map on a slightly larger scale in several colours is under consideration.

44. A number of special maps have been prepared and printed during the year and a large number of maps, plans and diagrams have been reproduced for other departments. Owing to the successful manner in which the Photo.-Litho. office has been able to cope with the publication of standard sheets and to clear off arrears of departmental work, more extra-departmental printing work of small size is wanted and can easily be dealt with.

45. *Drawing Office.*—The statement below gives a summary of the outturn of the offices during the year ending 30th September 1909. As mentioned above it is hoped that next year a considerable improvement in the preparation of the maps of India and adjacent countries on the scale of $\frac{1}{\text{million}}$ will be reported, and already a marked improvement in the quality of the drawing and typing has been effected through the efforts of the officer in charge.

Statement.

Class of map.	Scale.	Number of sheets in hand during 1908-09.	Number published.
General maps of India	1"=32 miles to 1"=256 "	40	14
India and adjacent countries . . .	$\frac{1}{\text{million}}$	30	5
Provincial maps	Various . .	25	9
District maps	$\frac{1}{4}$" and $\frac{1}{2}$" = 1 mile	20	15

ROYAL ASIA

Class of map.	Scale.	Number of sheets in hand during 1908-09.	Number published.
Standard maps	Various . .	512	368
Administration Report maps . . .	1" = 8 miles .	20	9
Plans of Cities and Cantonments . .	Various . .	136	133
Triangulation and Traverse charts . .	Various . .	136	117
Index maps	Various . .	72	23
Miscellaneous maps . . .	Various . .	82	49
Maps for other departments . . .	Various . .	214	162
	TOTAL .	1,287	904

46. *Engraving Office.*—The chief work of this office has consisted in the preparation of the general maps of India and about two-thirds of the outline and lettering of the new 32-mile map of India referred to in paragraph 43 has been cut on the copper. The plates of the 96 and 192-mile maps are undergoing correction and that of the 256-mile map has been brought up to date and an edition of it has been published.

In the copper plate printing section 58,241 impressions were pulled, and 218 plates were steel faced.

A new scheme for the payment and grading of the establishment very similar to those initiated by Major W. C. Hedley, R.E., for the Drawing and Photo.-Litho. offices in 1907 has come into force during the year. It is too early yet to report on the results, but there is every reason to believe that the greater power the scheme grants to the Surveyor General of dealing with good and bad workers according to their deserts, will lead to greater efficiency.

47. *Photo.-Litho. Office.*—The following statement shows the cost and the outturn of the office for the past few years:—

Statement.

Year.	Cost of the office.	Number of negatives taken.	Area of negatives taken in sq. inches.	Number of impressions pulled.	Number of departmental maps printed.	Number of extra-departmental maps, plans, etc., printed.	Total number of maps, plans, etc., printed.
	₹						
1905-06	1,87,634	1,926	1,025,942	1,284,968			
1906-07	1,77,529			1,123,001			
1907-08	1,88,966	2,361	1,581,286	1,563,453	891	1,175	2,066
1908-09	1,58,643	3,428	2,173,868	1,506,607	2,047	726	2,773

It is satisfactory to note that the outturn has increased considerably. This result has been obtained concurrently with the improvement in the quality of the maps which has been alluded to in paragraph 39 above. The marked decrease in extra-departmental work during 1908-09 is probably due in some measure to the fact that the Governments of Bengal and Eastern Bengal and Assam are undertaking

more of their own map reproduction. In spite of the increase of departmental work a much larger amount of small extra-departmental work than is now asked for could be undertaken by the Photo.-Litho. office. The improvement in outturn, quality and economy is primarily due to reorganisation of the office in 1906-08, but it has only been obtained through the efforts made by the officers in charge and their establishments and more particularly through the exertions of Messrs. Taylor and Vandyke, the heads of the photo. and litho. branches.

48. The new scheme of grading and paying the men according to their skill and outturn, as well as their length of service, alluded to in paragraph 52 of last year's report, is proving a success, and the officer in charge considers that the satisfactory results of the year's working are in great measure due to it. Colonel S. C. N. Grant, C.M.G., R.E., in his report on the Map Reproduction offices (Indian Survey Committee Report, pp. 141, 142) stated as his opinion that the Photo.-Litho. office, which had just been strengthened by the addition of 2 experts from England, could attain to an outturn of about 4,000 negatives a year, instead of 2,000 it could deal with in 1904, and that from 1,500,000 to 2,000,000 impressions could be obtained from the machines instead of the 1,300,000 obtained in 1904. In the year under report 3,428 negatives were taken and 1,506,600 pulls obtained; this cleared off all arrears.

In last year's report (paragraph 52) it was stated that the Photo.-Litho. office was believed to be in a position to deal with the yearly outturn of survey work; it has now been proved that this estimate was correct.

49. This year has been a good one in the matter of minor improvements in methods. Among these may be mentioned:—the introduction of "quick scaling" plan boards and of a large plan board upon which the fair drawings, on the 2-inch scale, of 16 standard sheets can be pinned up and photographed together for the preparation of degree sheets; the alteration of the large camera to take a negative $45\frac{1}{2}'' \times 31\frac{1}{2}''$, which allows of the reproduction on one negative of maps $43\frac{1}{2}'' \times 29\frac{1}{2}''$, and an important improvement in the treatment of helio plates with bitumen, which improves their printing qualities and prevents their deterioration.

50. The new plant received in 1908 and referred to in paragraph 53 of last year's report has had its effect on the outturn of process work, and during the last months of the year the process section of the office has also benefited considerably by the purchase of a large "Levy" diamond-ruled screen (133 lines to 1 inch). The process section pays for its own upkeep in the value of work done and forms a useful school for the training of the establishment in the higher methods of map reproduction, and experimental work in connection with these methods.

51. The cost of the Photo.-Litho. office for the year, excluding the cost of stores and plant obtained from England, is as follows:—

	₹
Supervision charges	8,837
Establishment	1,29,974
Contingent	19,832
TOTAL	1,58,643

The cost for 1907-08 was about ₹30,000 higher, but the expenditure of that year cannot be considered normal, as it included the pay of Major Hedley and his assistant, Sergeant Lucas. The normal cost of the establishment will probably rise slightly in the next few years as the men attain more skill and earn higher rates of pay but provided that the survey outturn increases, as is likely, the rise in cost will be small in proportion to the increased value of the work done. A sum of ₹42,531, as compared with ₹49,828 in 1907-08, has been recovered in cash and book debit payments for extra-departmental work and the value of the uncharged for work carried out for the Government of India and the department at office rates is ₹1,29,703 as compared with ₹1,30,178 in 1907-08.

52. *Map Record and Issue Office.*— The face value of the maps received in the Map Record and Issue office amounts to ₹2,33,034; of this sum, ₹46,654 is the face value of maps printed at Dehra Dún and in the Engraving office; the

remainder is the face value of maps printed in the Photo.-Litho. office. The following statement shows the details:—

Statement.

Class of maps.	Scale.	Number of different maps of each class published.	Value.
			₹
(1) General maps of India . .	1″=32 to 1 =256 miles	5	4,576
(2) India and adjacent countries .	$\frac{1}{\text{million}}$	8	2,854
(3) Provincial maps . . .	Various	20	12,458
(4) District maps . . .	¼″ and ½″=1 mile	9	1,950
(5) Standard sheets . . .	Various .	337	1,48,053
(6) Atlas sheets . . .	1″=4 miles .	255	24,766
(7) Administration Report maps	Various .	47	1,488
(8) Plans of Cities and Cantonments.	Various .	74	20,014
(9) Triangulation and Traverse charts.	Various .	110	2,750
(10) Index maps	Various .	20	2,000
(11) Miscellaneous maps . .	Various .	101	12,125
	TOTAL .	986	2,33,034

The number of original maps, volumes of computations, etc., received into store from other departments or branches of the office was 8,515, and 4,985 were issued.

53. The original Revenue survey records of the districts in Bengal were transferred to the Bengal Drawing office for storage. The records transferred were the following:—

(1) Atlas volumes	81
(2) Village plans	426
(3) Traverse records	234
TOTAL	741 volumes.

54. The total number of printed maps issued during the year was 1,04,661 of an aggregate value of ₹1,00,200. The details were as follows:—

	No. of sheets.	Value.
		₹
To Government officials .	52,783	40,653
„ India Office . . .	6,538	9,171
„ Departmental issues .	21,400	27,519
„ Private individuals .	20,118	18,448
„ Agents	3,822	4,409
TOTAL .	1,04,661	1,00,200

55. The transfer of the Forest maps to the Forest Map office, Dehra Dún, was continued during the year. The sheets of districts Damoh, Nimár, Hoshangábád and Betúl in the Central Provinces, comprising some 20,114 copies, together with 2,574 copies of the Punjab Forest maps being despatched for storage to the officer in charge of that office.

56. The revision of the map catalogues is still in hand.

57. The work of overhauling and registering the original maps and volumes has also been steadily proceeded with and that of examining the coloured originals, corrected prints, etc., has been completed. Most of the originals have been classified and stored in volumes, and it is hoped shortly to complete this work which was begun five years ago.

58. The new method of enclosing the printed copies of the 1-inch standard sheets in zinc cases with let-down fronts and storing these in racks arranged in groups for those composing each $\frac{1}{\text{million}}$ and degree sheet has been continued during the year and all the new 1-inch standard sheets have been stored in this manner. Considerable improvements have also been effected in the arrangements of the rooms used for the sale of maps to the general public and in the office generally, by the provision of additional fans and electric lighting.

59. *Mathematical Instrument Office.*—During the year under report, *i.e.*, from 1st April 1908 to 31st March 1909, there has been a decrease in the demand made on this office for instruments. During the last three years, *i.e.*, 1906-07, 1907-08, and 1908-09, the value of instruments, etc., issued to public offices has been R3,82,345, R3,66,334 and R3,31,250, respectively; the value of the repairs to instruments received for repair has been R42,181, R42,542 and R52,278, respectively; and the value of instruments received from Government officers when "no longer required" has been R58,128, R70,486 and R71,241, respectively.

The book value of the stock in the serviceable store at the end of each year during that triennial period was R5,35,535, R7,62,415 and R9,77,261, respectively. The larger stock in hand at the end of the year under report is due to an excess of receipts over the issues; the receipts included nearly four lacs worth of instruments, for which indents had been sent Home in previous years in order to replenish the stock which had run very low.

The book value of the instruments, etc., in the repairable store at the end of each of the last three years was R1,12,389, R98,578 and R1,21,746, respectively. All instruments for which there was any great demand were sent to the workshop for repairs and transferred to the serviceable store for issue, as soon as possible.

Two "profit and loss" statements have been prepared in accordance with the orders of the Comptroller General—one showing the results of the operations of the stores branch and the other of the workshop. The stores statement shows a profit of R14,606, and the workshop statement a loss of R6,782 due to the issue of grain compensation allowance to the men, which was an exceptional charge.

The number of men and boys employed at the end of each of the last three years was 451, 457 and 464, respectively.

The total value of issues during the year under report shown in the "profit and loss" statement on account of stores, amounts to R3,44,971 as against R3,77,118 for the previous year, and the value of the work done in the workshop during each of the last three years, was R2,16,730, R2,54,916 and R2,41,215, respectively.

The value of instruments, etc., manufactured in the workshop during each of the last three years was R87,588, R1,11,901 and R91,571, respectively, and the value of instruments, etc., purchased locally during each of the last three years, was R4,189, R1,943 and R3,052, respectively.

The value of instruments, material, etc., obtained from England through the Director General of Stores, during each of the last three years was R4,36,240, R4,94,985 and R4,56,322, respectively.

During the year Mr. Woodhouse, the senior Assistant Manager, took leave for three months to England.

Towards the end of the year under report two additions to the main building were completed; one consisted of an extension to the theodolite and general repair room on the ground floor, with a drawing office and painter's shop on the first floor; the other, an extension to the main porch for the storing of packages, etc., until the invoices of their contents are received and they can be disposed of, with a room for packing and despatching above it. These additions have been needed for many years and give great relief to the over-crowded workshops. Certain alterations were made to the brass foundry and main workshops to ensure better ventilation and light, and these have also proved satisfactory.

To the workshop have been added several machines, amongst them a large planing machine for the manufacture of straight-edges and metal rules of all sorts which were formerly obtained from England, and also for "trueing up" lathes and machines.

Many more self-centring stands for theodolites have been fitted up during the year. The workshops have made further progress in the way of repairs and manufactures, and it is hoped that a great many more instruments which have in the past been procured from England may in future be manufactured here, and unless there are very exceptional demands during the next two years there will not be any necessity to import many instruments from England except those of the most delicate construction, or such as are only required in small quantities, or those which for special reasons it is advisable to continue importing, such as thermometers and optical glasses.

Stock-taking of all the stores has been carried on during the year, and where discrepancies have been found, the necessary enquiries and book corrections have been made.

The price list mentioned in the last report is nearing completion, and it is hoped that it will be issued shortly.

BRANCH OFFICES.

TRIGONOMETRICAL OFFICE.

60. The Trigonometrical Branch was under Colonel S. G. Burrard, R.E., F.R.S., Superintendent, Trigonometrical Surveys, to the 15th August 1909, when he was deputed to England in connection with the triennial conference of the International Geodetic Association. He made over charge of his duties to Captain H. H. Turner, R.E., who continued in office to the end of the year.

Captain H. H. Turner, R.E., held charge of the technical offices up to the 15th August from which date Lieutenant G. F. T. Oakes, R.E., continued the duties to the end of the year.

Mr. T. A. Pope, in charge of the Forest Map office, continued the supervision of the Photographic office throughout the year.

Five Probationary Sub-Assistant Superintendents of the Survey of India and six Probationary Assistant Superintendents of the Burma Land Records, were put through a course of training during the year.

61. *Computing Section.*—The following computations were carried out in the Computing office :—

(*a*) Computations of the remaining heights and extra azimuths and discrepancy per mile in common sides of triangles of the North-East Longitudinal series.

(*b*) Compilation of the azimuth list of intersected points, co-ordinate list and alphabetical index of stations and well-known intersected points.

(*c*) Examination of the triangulation charts of the North-East Longitudinal series.

(*d*) Captain Gibbon's triangulation examined, and experimental computations done in connection therewith, and Khan Bahadur Sher Jang's observations for heights in Persia reduced.

(*e*) The cause of discrepancy between the triangulations in Persia by Lieutenant Crookshank and Yusuf Sharif was investigated.

(*f*) Rai Bahadur Lal Singh's observations for heights in Chinese Turkistán and Kansu were reduced.

(*g*) Certain computations were done for Sir F. Younghusband in connection with the ascent of peak K-2 in Kashmír by the Duke of Abruzzi.

(*h*) Old records were examined and experimental computations made to determine the cause of discrepancy pointed out by the Superintendent in charge Burma Surveys between the Great Trigonometrical values of certain points and those obtained by No. 3 Party and No. 19 Party in Burma and Malabar Coast series respectively.

(*i*) Computations were carried out and information supplied to the Geodetic Institute. Ferraro's and Merriman's formulæ for computing mean and probable errors of triangulation were compared and tested.

(*j*) Computations for extending Bessel's Table of refraction were done for the Director of the Hongkong Observatory.

(*k*) Information for the adjustment of level circuits was collected from the English and American publications.

(*l*) The heights of stations of the Calcutta Longitudinal series were adjusted in terms of the values obtained by spirit levelling.

(*m*) Two computers were employed for three months on computations in connection with the levelling volume.

(*n*) The computations of a table of distances in feet corresponding to a subtense bar of ten feet are in hand.

(*o*) Certain Tables of the 4th Edition of the Auxiliary Tables are being extended to 45° in latitude for incorporation in a smaller edition of the Tables for use of explorers and surveyors.

(*p*) Computations of the Bangkok Secondary series are being revised with the object of determining the best triangulated co-ordinate value of Bangkok, the capital of Siam.

(*q*) Compilations of data for Frontier and Trans-Frontier Degree triangulation charts are in progress.

(*r*) Major Lenox-Conyngham's papers on Pendulum Observations were printed and distributed.

(*s*) *Routes in the Western Himalaya and Kashmir* and a catalogue of scientific books and subjects in the Trigonometrical Branch office were passed through the press.

(*t*) The synoptical volume of the North-East Longitudinal series is nearly ready and will shortly be issued.

(*u*) "A series of papers on the measurement of bases by means of wires" is passing through the press.

(*v*) Data from the records was supplied to 53 officers.

(*w*) The meteorological observations were continued as usual.

(*x*) The necessary professional aid in connection with the protection of stations was rendered to the office of the Superintendent, Trigonometrical Surveys.

Five hundred and twenty-two stations were repaired by the district officers at a cost of R3,296.

Out of 333 districts from which the reports are annually due, 14 failed to make returns.

62. *Drawing Section.*—Ninety-four sheets on the $\frac{1}{4}$-inch scale of Dr. Stein's exploration in Chinese Turkistán were compiled. The drawing of all, except 4 hill sheets, has been completed. The sheets are now being sent to press, as rough corrected proofs of the outline sheet are being received back from Dr. Stein.

The following maps have been drawn and sent to press:—

(1) Thirteen Geological charts for Part IV of the Himalayan Geography.

(2) Forty-two Triangulation charts and 3 special charts on the 1-inch scale of the North-East Longitudinal series for inclusion in the Synoptical volume.

(3) An Index chart to the Great Trigonometrical Survey of India to be printed in colours, scale one inch=96 miles.

(4) A magnetic chart, scale one inch=96 miles.

(5) Four degree triangulation charts, scale one inch=4 miles.

(6) One plate showing progress of triangulation in India for the International Conference.

(7) One orographical chart of Region No. 7, scale one inch=128 miles.

(8) One chart to illustrate the areas in which gravity is in excess and defect, scale one inch=256 miles.

(9) Three preliminary isomagnetic charts.

(10) Triangulation charts for Professor Helmert.

(11) One levelling chart for International Conference.

(12) Index Map of Dr. Stein's Explorations for the Viceroy.

(13) Index Map of Dr. Stein's Explorations for the Board of Scientific Advice.

(14) Index Map to $\frac{1}{\text{million}}$ and degree sheets.

(15) Punjab survey sheet No. 308 S.W.

(16) Five miscellaneous maps.

The following are in hand:—

(1) An Index chart of the North-East Longitudinal series.
(2) Index chart of the degree triangulation charts on the Frontier of India.
(3) Map of Persia, scale one inch=40 miles.
(4) Six Punjab level sheets.
(5) Ninety-six degree triangulation charts of the Frontier.
(6) Four $\frac{1}{\text{million}}$ sheets.
(7) Dehra Dún Municipality and Cantonments in 4 sheets, scale 12 inches =1 mile.
(8) Guide Map of Mussooree and Landour, 8 inches=1 mile.
(9) Captain Wahab's Height Indicator for 1-inch scale.

The proofs of all maps have been examined and corrections carried out as usual. Eight hundred and one maps were coloured.

63. *Photo.-Zinco. Section.*—One thousand four hundred and seventy-eight maps and diagrams were photographed against 1,467 during 1907-08 and 267,732 pulls taken against 258,510 taken during the previous year. The lithographic machine press has been in full work throughout the year on Cantonment and Forest maps and triangulation charts. The printing of Dr. Stein's 94 maps, in 6 and 7 colours, commences next season. These alone will keep the machine fully occupied for two years without printing other departmental work. It will therefore be necessary to ask for the assistance of the Calcutta office in the publication of these maps in order that there may be no delay in publication of other maps.

64. Photographs of the sun were taken on 336 days during the year.

FOREST MAP OFFICE.

65. This office remained throughout the year under the superintendence of Mr. T. A. Pope, Superintendent, 2nd Grade, except for one month from the 3rd May 1909, while he was absent on privilege leave, when Mr. A. Descubes, Superintendent of Forest Map Records, officiated in charge.

The number of maps issued to Forest and other officials and to the public during the year was 7,689, of which 3,335 were coloured maps. The number issued last year was 11,177. The value of the maps issued was, however, considerably greater during the past year, the amount realised by the sale of maps being R3,312, as against R2,018 realised last year, and R1,750 in 1906-07. Of this amount, R2,244 was adjusted by book debit, and R1,068 accrued from sales to private individuals and trading companies.

66. The following is a brief summary of the mapping executed during the year:—Of the standard sheets of Forest Surveys 62 were published, 17 were in the press, and 94 were in various stages of preparation. Of the working plan and other special Forest maps, 8 were published, 9 were in the press, and 19 were in hand. Two general maps of India, on the 48-mile scale, were put in hand for the Inspector General of Forests' Quinquennial Report for 1904-09, and also 6 on the 96-mile scale, showing distribution of the principal Indian timber growth.

Provincial Forest maps of Burma and the Central Provinces, on the 32-mile and 16-mile scales respectively, were published. A similar map of Bengal, on the 32-mile scale, was completed and sent to press, and one of the Punjab, on the 16-mile scale, was commenced.

The drawing of the new district Forest maps of the Madras Presidency, on the quarter-inch scale, which was commenced last year at the instance of the Conservators of the three Circles, has made good progress during the year. The fair drawing of the South Canara, Madura, Tinnevelly and Cuddapah maps was nearing completion at the end of the year and they will be sent to press early in the ensuing year; that of the Coimbatore district map has recently been put in hand. Arrangements are being made to publish these district maps in the first place as ordinary editions omitting all special Forest features.

Blue impressions of 18 of the new 2-inch standard sheets have been received during the year, for the insertion of additional Forest details in order to publish them as special Forest editions. Of these, two have been published and the remainder are in hand. Out of the 36 blue impressions of 2-inch sheets received last

year, 16 have been published and distributed, 6 returned to press for publication and the others are in various stages of progress. In future the Forest details are to be inserted on *black* impressions of the sheets, carefully printed on thick drawing paper, instead of on blue prints as heretofore. This method has the advantage of furnishing originals for photography complete in every respect, thus saving the trouble of making separate helio-plates from the blue prints containing the forest information only, and of sur-printing from these plates upon previously printed copies of the public edition.

During the year, 30,944 copies of Forest maps were received from the Map Record and Issue Office, Calcutta, and other offices, for storage. A large number of maps have yet to be received from Calcutta, and the erection of new racks for their reception has gone on steadily throughout the year. As mentioned in paragraph 68 of last year's Report, there is insufficient space in the present building for the accommodation of these maps when received, and proposals have been submitted for an extension of the building. It is roughly estimated that space will eventually be required for about 5 lakhs of printed maps, whereas there is at present only sufficient rack accommodation for about half that number. The proposed scheme of extension includes the erection of an upper storey over a portion of the present building for the accommodation of the tidal establishment of No. 25 Party.

LOCAL DRAWING OFFICES.

67. *United Provinces Drawing Office.*—(*a*) This office was under the administrative control of the Superintendent, Northern Circle, and Mr. J. M. Kennedy, Extra Deputy Superintendent, was in charge. The working establishment was 1 surveyor, 1 computer, 1 typer and 17 draftsmen, permanent or temporary.

(*b*) Eight 2-inch standard sheets in the old form, namely, 54 $\frac{I}{2\ \&\ 6,\ 3\ \&\ 7}$, 54 $\frac{J}{9\ \&\ 13}$, 54 $\frac{M}{1\ \&\ 5}$, 63 $\frac{F}{9\ \&\ 13}$, 63 $\frac{I}{11\ \&\ 15}$, 63 $\frac{J}{1\ \&\ 5,\ 11\ \&\ 15}$ and nine in the new, namely, 54 $\frac{N}{3,\ 7,\ 11,\ 12,\ 15,\ 16}$, 54 $\frac{O}{9,\ 13}$, 63 $\frac{K}{2}$ were drawn, wholly or in part, and one 1-inch old standard sheet was partially revised, namely, 63 $\frac{C}{12\ \&\ 16}$; the total area compiled and mapped being 5,532 square miles. The 29 traverse charts prepared cover an area of 5,087 square miles. Three district maps, namely, Farrukhábád, Mainpuri and Etah, were prepared on the $\frac{1}{2}$-inch scale, comprising an area of 5,121 square miles.

(*c*) The total cost for this office for the year under report was R17,745.

(*d*) The proposed work for the ensuing year is the 2-inch mapping of standard sheets in which the districts of Hamírpur and Bándá fall, using the latest Land Records surveys and supplementing where necessary for the compilation of the sheets by the best other material available. The traverse charts will also be continued and Jálaun, the last of the series of districts maps, will be completed.

68. *North-West Frontier Drawing Office.*—(*a*) This office was under the administration of the Superintendent, Northern Circle, and was under the executive charge of Mr. G. P. Tate throughout the year.

(*b*) The map of Turkistán is nearly completed and will be finished by about November 1909.

(*c*) $\frac{1}{\text{million}}$ sheets Nos. 30 and 35 are in hand, and the hills are being reduced by pentagraph from the $\frac{1}{4}$-inch sheets and $\frac{1}{2}$-inch sheets, from which the $\frac{1}{\text{million}}$ sheets have been compiled. These features will be transferred, to "dust on" blue prints and then brush shaded.

(*d*) Degree sheets 8 D and K, and 9 M were redrawn and submitted for publication.

69. *Simla Drawing Office.*—(*a*) Lieutenant J. D. Campbell, R.E., held charge of this office which consisted of four permanent and five temporary draftsmen. On the 1st October 1908, the compilation of 13 degree sheets had been completed and 19 more were in hand. The fair drawing of 4 sheets had been commenced. During the year under report the number of sheets in hand has risen to 45, whilst 18 more have been asked for by the Chief of the Staff and the collection of materials for the latter has been started. The fair drawing of

13 outline sheets has been completed and 7 more are in hand. Experiments have been made in hill shading with various mediums and fair results have been obtained with pencil and stump shading on Bristol boards. Eight degree sheets (numbers 25 I, J, K, M; 10 C; 3 M, N, O) with hills thus drawn, have been forwarded to Calcutta for proofs. The histories of all the degree sheets which have been compiled in manuscript will be sent for publication at the same time as the sheets concerned.

(*b*) The total cost of this office for the year under report was ₹13,736.

70. *Burma Drawing Office.*—(*a*) Mr. T. Shaw who was re-employed in 1907 after retirement from the department remained in charge throughout the year. Messrs. O. D. Smart and C. S. Littlewood were attached to the office for short periods. Mr. A. J. Smith, one of the two draftsmen whose services were lent to the department by the Ordnance Survey of England was temporarily posted to the office in June for the purpose of giving instruction to the draftsmen. A photographic section was added to the office at the beginning of the recess and Mr. Murphy of the head-quarters office, Calcutta, was attached to the office for the few weeks for the purpose of starting the section and training a photographer. The office now carries out all the photographic and vandyking work of the parties recessing at Bangalore with excellent results and much time and expense are thereby saved. The work of the office consisted of the preparation of degree sheets, carrying out the arrears of the mapping of field parties, examination of fair maps and proofs and the preparation of colour patterns.

(*b*) One degree sheet No. 93 L was completed and will be sent to press before the end of the year. Four standard sheets, namely, $58\frac{A}{1}$, $84\frac{M}{13, 15, 16}$ comprising an area of 1,778 square miles were completely drawn and 14 partly. Sixty-four standard maps were examined and sent to press, 54 colour patterns were prepared, and 74 proofs were examined. In the photographic section 42 outline sheets were vandyked and 48 enlargements and reductions were made. The services of several draftsmen were lent to various parties during the recess.

(*c*) The cost of the office for the year under report was ₹20,403.

71. *Bengal Drawing Office* (*Standard Mapping Section*).—(*a*) This section of the Bengal drawing office has remained under the administration of the Surveyor General through the Director of Surveys, Bengal, throughout the year; the remainder of the office having been transferred to the Bengal Government from 31st January 1909.

(*b*) The following 22 standard maps on the scale of 2 inches=1 mile and covering a land area of 4,510 square miles have been completed and submitted for publication during the year, *viz.*, sheets $72\frac{N}{11}$, $72\frac{O}{5, 6, 7}$, $79\frac{B}{12, 16}$, $79\frac{C}{1, 5, 6, 9}$, $79\frac{F}{4, 7, 8, 11, 12, 16}$, $79\frac{G}{5, 9, 10, 13}$, $79\frac{K}{1, 5}$. Sheets $72\frac{N}{12, 15, 16}$, $72\frac{O}{9, 10}$ and $79\frac{F}{3, 15}$ are nearing completion; sheets $72\frac{O}{13, 14}$, $72\frac{K}{8, 12}$, $72\frac{L}{5}$, the northern section of $72\frac{P}{7}$ and $64\frac{O}{10}$, have complete details transferred on them in pencil; sheets $72\frac{P}{6}$ and $64\frac{O}{11}$ are completely plotted, and the following sheets have been projected but not plotted as yet,— $72\frac{K}{4}$, $72\frac{L}{1, 2, 6, 7, 9, 10}$, $72\frac{O}{12}$, $72\frac{P}{9, 10, 11}$ and $64\frac{O}{15}$. Sheet $72\frac{K}{11, 15}$ (old No. 203) in four sections although ready in all other respects could not be completed during the year owing to the non-receipt of the village lists of two *thánas* of South Monghyr which are required to correct the spelling of the village names. Sheet $72\frac{N}{8}$, of which the preliminary edition was published without village boundaries, has since had village boundaries drawn on it in black. The work of adding boundaries in black for the publication of special provincial editions has now since been stopped pending further instructions.

(*c*) The following items of work have been done for the Map Publication office :—

1. Twenty-eight grey prints have been coloured.
2. Fiscal limits and cultivation have been coloured on 42 black prints.
3. Forty-nine uncorrected proofs have been examined and corrected with regard to colours and other details. An additional copy of each

of these prints has been kept for reference in the office. In addition, 54 copies of maps not published in colours have been coloured for the office.

(*d*) Twenty-seven traverse charts of North Bihár, 8 of Ránchi district and 3 of Chittagong district have been sent for publication during the year. Their numbers are as follows :—$72\frac{F}{11, 12, 15, 16}$, $72\frac{G}{1, 5, 9, 10, 13, 14}$, $72\frac{J}{3, 4, 7, 8, 11, 12, 14, 15, 16}$, $72\frac{K}{1, 2, 5, 6, 9, 10, 13, 14}$, $73\frac{B}{1, 2, 3, 5, 6, 7, 9, 11}$, and $79\frac{N}{9, 10, 15}$. One other chart of Chittagong district $79\frac{N}{14}$ is practically ready and will be sent for publication very shortly. All the other charts of this district will in future be drawn in the Eastern Bengal and Assam Drawing office.

(*e*) The publication of a special edition of the standard maps of Bengal on the 1-inch scale with village boundaries is under consideration. If it is decided to publish this edition, all future traverse charts of Bengal will be prepared from them, except such as may be urgently needed for topographical surveys which will have to be separately projected and plotted and the village boundaries transferred on to them from the *thána* maps which are prepared on the 1-inch scale.

(*f*) The 8 traverse charts of Ránchi district which have been completed, have been prepared by projection, plotting of trijunctions and transferring of village boundaries on to them from 1-inch reductions of cadastral maps, as no standard maps of this area have yet been commenced. In addition the following 17 charts of this district have been projected and plotted, *viz.*, $73\frac{A}{3, 4, 6, 7, 8, 11, 12, 14, 15, 16}$, $73\frac{B}{10, 13, 14, 15}$ and $73\frac{E}{3, 4, 8}$. Of these, $73\frac{A}{8, 12}$ and $73\frac{B}{10}$ have village boundaries partially transferred on to them in pencil. Further work on these charts has been postponed pending final orders on the question of publication of a special provincial edition of the standard maps.

(*g*) The total cost of the office for the year under report was R33,069.

NEW STANDARD MAPS.

72. The following statements show that the number of sheets surveyed is considerably more than the number drawn, but this is due to the fact that in column 4 only those sheets which have been drawn and finally passed by Circle Superintendents up to September 30th, 1909, have been included. A large number of those sheets shewn in column 6 will very shortly be submitted for publication. The number of sheets published in the year under report is 174, which compares very favourably with the number published in 1907-08, namely, 85, and it is not anticipated that it will be difficult in future for the publication office to keep well up to date in dealing with the number of maps submitted for publication. The Table as now published gives a complete record of the preparation and the publication of all the new standard maps for the year under report.

Statement showing the progress made in the preparation of the "Standard Sheet" Series of Maps on the scale 1-inch = 1 mile during the year ending September 30th, 1909.

Locale.	Sheets surveyed or compiled.	Total.	Sheets drawn.	Total.	Sheets in hand on September 30th, 1909.	Total.	Remarks.
1	2	3	4	5	6	7	8
Central Provinces, Central India and Berár.	46 K/9, 13; 46 O/1, 2, 5, 6, 9, 10, 13, 14		54 P/4, 7, 8, 12, 16; 55 M/13		46 K/9, 13; 46 O/1, 2, 5, 6, 9, 10, 13, 14		
...	55 H/1, 2, 3, 5, 6; 55 I/10		.....		55 H/1, 2, 3, 5, 6; 55 I/10		
...	55 L/2, 3, 4, 6, 7; 55 M/1, 2, 3, 5, 9		.....		55 L/2, 3, 4, 6, 7; 55 M/1, 2, 3, 5, 9		
...	55 N/5; 64 A/1, 5, 9, 10, 13	32	.....	6	55 N/5; 64 A/1, 5, 9, 10, 13	32	
United Provinces	54 I/2 & 6, 3 & 7; 54 J/9 & 13		54 I/2 & 6, 3 & 7; 54 J/9 & 13		54 M/9; 54 O/1, 5, 7, 10, 11, 12, 14, 15, 16		
...	54 M/1 & 5; 54 N/3, 7, 11, 12, 15, 16		54 M/1 & 5; 54 N/3, 7, 11, 12, 15, 16		63 C/2, 3, 4, 6, 7, 8		
...	54 O/9, 13; 63 C/12 & 16		54 O/9, 13; 63 C/12 & 16		63 G/12, 16; 63 K/2, 4, 8		
...	63 F/9 & 13; 63 I/11 & 15; 63 J/1 & 5		63 F/9 & 13; 63 I/11 & 15		.....		
...	63 J/11 & 15; 63 K/2	18	63 J/1 & 5, 11 & 15; 63 K/2	18	.....	21	
Bombay	46 O/3, 7, 11	3	46 K/1, 2, 5, 6, 14	5	46 O/3, 7, 11	3	
Madras and Coorg	48 P/15; 49 N/13, 14		49 M/5, 9, 10, 13		48 P/15; 49 M/14; 49 N/13, 14		
...	58 A/7, 8, 9, 10, 13, 14	9	58 A/1, 2, 3, 4, 5, 6	10	58 A/7, 8, 9, 10, 13, 14	10	
Bengal	72 N/11; 72 O/5, 6, 7, 9, 10		72 N/11; 72 O/5, 6, 7		64 O/10, 11, 15; 72 K/4, 8, 11, 12, 15		
...	79 B/12, 16; 79 F/7, 11; 79 K/1, 5		79 B/12, 16; 79 C/1, 5, 6, 9; 79 F/4, 7, 8, 11, 12, 16		72 L/1, 2, 5, 6, 7, 9, 10; 72 N/12, 15, 16		

Bengal—*contd.*	.....		79 $\frac{G}{5, 9, 10, 13}$, 79 $\frac{K}{1, 5}$		72 $\frac{O}{9, 10, 12, 13, 14}$		
...	.....	12	.....	22	72 $\frac{P}{6, 7, 9, 10, 11}$, 79 $\frac{F}{3, 15}$	30	
Eastern Bengal and Assam.	78 $\frac{P}{9, 10, 12, 13, 15, 16}$	6	.....	0	78 $\frac{P}{9, 10, 12, 13, 15, 16}$	6	
Burma	84 $\frac{J}{9, 10, 11, 12, 13, 14, 15, 16}$		84 $\frac{K}{2, 4, 5, 6}$		84 $\frac{J}{9, 10, 11, 12, 13, 14, 15, 16}$		
...	84 $\frac{K}{9, 13, 14}$, 84 $\frac{M}{1, 5, 9, 13, 15, 16}$		84 $\frac{M}{13, 15, 16}$		84 $\frac{K}{9, 13, 14}$, 84 $\frac{M}{1, 5, 9}$		
...	93 $\frac{A}{9, 10, 11, 12, 13, 14, 15, 16}$		.....		93 $\frac{A}{9, 10, 11, 12, 13, 14, 15, 16}$		
...	93 $\frac{N}{8, 12, 16}$, 93 $\frac{O}{5, 6, 9, 10, 13, 14}$		.....		93 $\frac{N}{8, 12, 16}$		
...	102 $\frac{C}{1, 2, 3, 6, 7, 11, 14, 15}$		.....		93 $\frac{O}{5, 6, 9, 10, 13, 14}$		102 $\frac{G}{1}$ and $\frac{G}{2}$ are being drawn in one sheet.
...	102 $\frac{G}{1, 2, 3}$		.....		94 $\frac{F}{6}$		102 $\frac{C}{10}$ and $\frac{C}{11}$ are being drawn in one sheet.
...	.....		.....		102 $\frac{C}{1, 2, 3, 6, 7, 11, 14, 15}$		
...	.....	45	.....	7	102 $\frac{G}{1, 2, 3}$	43	102 $\frac{B}{4}$ and $\frac{C}{1}$ are being drawn in one sheet.
Punjab	38 $\frac{L}{3, 4, 7}$, 38 $\frac{P}{1, 2, 5, 6, 7, 8, 9}$		38 $\frac{K}{12}$, 38 $\frac{L}{3, 6, 7}$, 38 $\frac{N}{8, 11, 12, 16}$		38 $\frac{L}{4}$, 39 $\frac{I}{2, 3, 4, 8, 16}$		38 $\frac{K}{12}$ was redrawn during year under report.
...	39 $\frac{I}{2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16}$		38 $\frac{O}{2, 6, 8, 10, 11, 12, 13, 14, 15, 16}$		39 $\frac{J}{1, 5, 13, 14}$, 39 $\frac{M}{1, 2, 3}$, 43 $\frac{B}{15, 16}$		
...	39 $\frac{J}{1, 5, 13, 14}$, 39 $\frac{M}{1, 2, 3}$		38 $\frac{P}{1, 2, 5, 6, 7, 8, 9}$		43 $\frac{F}{3, 4, 7, 8}$, 52 $\frac{D}{12, 16}$, 52 $\frac{H}{4, 8}$		38 $\frac{N}{8, 11}$, second edition.
...	43 $\frac{B}{7, 8, 12, 15, 16}$		39 $\frac{I}{5, 6, 7, 9, 10, 11, 12, 14, 15}$		53 $\frac{A}{2, 12}$, 53 $\frac{E}{1, 2, 5, 6}$		38 $\frac{O}{13}$, rejected and redrawn.
...	43 $\frac{C}{4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}$		43 $\frac{B}{4, 7, 8, 11, 12}$		.....		
...	43 $\frac{F}{3, 4, 7, 8}$		43 $\frac{C}{2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}$		.....		
...	.....	53	43 $\frac{G}{12}$, 43 $\frac{H}{5, 9}$	57	.....	29	
	TOTALS	178		125		174	

Statement showing progress made in the publication of the "Standard Sheet" Series of Maps on the scale 1-inch=1 mile during the year ending September 30th, 1909.

Locale.	Sheets received for publication during the year.	Total.	Sheets published during the year.	Total.	Remarks.
1	2	3	4	5	6
Central Provinces, Central India and Berár.	54 L 8, 12, 16; 54 P 4, 7, 8, 12, 16		54 L 8, 12, 16; 54 P 3, 4, 7, 8, 11, 12, 15		
...	55 I 5, 6; 55 H 4, 7, 8, 12, 16; 55 M 13		55 H 4, 7, 8, 12, 16; 55 I 5, 6, 11; 55 M 13		
...	.....	16	55 N 1	20	
United Provinces	54 L 7; 54 N 3, 7, 12, 15, 16; 54 O 1, 5, 9, 13		54 L 7, 11, 15; 54 N 4, 8, 11, 12, 15, 16		
...	.....	10	54 O 1, 5, 9, 13; 63 G 15; 63 J 12, 16	16	
Bombay	46 K 6, 10, 14, 16; 46 O 4, 8, 12, 16		46 K 4, 6, 7, 10, 11, 12, 14, 15, 16		
...	.....	8	46 O 4, 8, 12, 16	13	
Madras and Coorg	49 M 5, 9, 10, 11, 13, 15, 16; 58 A 5	8	49 M 5, 11, 16	3	Sheets 52 H 14, 58 A 1, 2, 3, 4, 6, 78 P 8, 93 E 4, 93 P 13, 14, 102 D 1, 2, were despatched by Superintendent, Burma Surveys, on September 30th, 1909, but were received in Calcutta in October 1909 and have been registered for column 2 for year 1909-10.
Bengal	72 N 7, 11; 72 O 5, 6, 7; 79 B 12, 16		72 N 2, 3, 7, 8; 72 O 3, 5; 79 C 2, 10, 13, 14		
...	79 C 1, 5, 6, 9; 79 E 7, 8, 11, 12, 16		79 G 1, 2, 6, 10, 13		
...	79 G 1, 5, 9, 10, 13	21	.....	15	

Eastern Bengal and Assam.	78 P 1, 2, 3, 4, 5, 6, 7, 11, 14; 79 J 4		78 P 3, 4, 5, 6, 11; 79 J 4	
...	79 K 1, 5; 83 A 12; 83 B 9		79 K 1, 5; 83 A 12	
...	.....	14	83 B 5, 9, 13	12
Burma	84 K 2, 3, 4, 5, 6, 8, 11, 12, 15, 16; 84 L 1		84 J 4, 8; 84 K 1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 15, 16	
...	84 M 2, 6, 10, 13, 14, 15, 16; 93 A 1, 5; 93 C 5		84 L 1, 2; 84 M 2, 3, 4, 7, 8, 11, 14; 84 N 5, 12, 16	
...	93 E 8; 93 P 11, 15; 94 B 9, 10, 13, 14, 15		84 O 5; 93 E 8; 93 O 15, 16; 93 P 10	
...	94 F 2, 3; 102 C 4, 8, 12; 102 D 3, 5, 9		94 A 2, 11; 94 B 9, 10, 11, 12, 14, 15, 16	
...	.....	37	94 C 9, 16, 13, 14; 94 F 1, 2, 4, 7, 8, 10, 11, 12	52
Panjab	38 K 12; 38 L 12, 15, 16; 38 N 8, 11, 12, 16		38 K 12, 16; 38 L 1, 5, 6, 8, 9, 15, 16	38 N 8, 11, second edition.
...	38 O 2, 5, 6, 8, 9, 10, 14, 12, 14, 15, 16; 38 P 3, 4		38 N 8, 14, 15, 16; 38 O 3, 4, 5, 7, 9	
...	39 F 15, 16; 39 I 13		38 P 4; 39 I 13; 39 J 2, 3, 6, 7, 8, 9, 10, 11, 12	
...	39 J 2, 3, 4, 6, 7, 8, 9, 10, 11, 12; 43 B 4		39 K 1; 39 O 5, 11; 43 B 1, 2, 3, 4; 43 C 1	
...	43 C 1, 2, 3, 4, 6	40	53 A 6, 7, 11, 15, 16	43
	TOTAL	154		174

Note.—In addition 11 Standard Sheets in the old form were printed as new publications during the year, and 4 were received for publication.

ESTABLISHMENT.

73. The following officers have been appointed to the department:—

Lieutenants P. G. Huddleston, R.E., and K. Mason, R.E.

74. From the Provincial Service five officers retired:—

Messrs. W. M. Kelly, S. F. Norman, L. F. Berkeley, C. S. Kraal and A. Descubes: two resigned: Messrs. F. W. Marten and B. F. Cooper; and five died: Messrs. C. G. S. Wood, Rahmatulla, K. S., M. J. Sheehan, H. W. McDonald and A. G. Wiseman.

Five officers have been appointed to the Provincial Service as probationers.

75. Four officers have been transferred from the old to the new Provincial Service and nine surveyors have been promoted to the Upper Subordinate Service.

76. The services of the following officers are deserving of special mention:—Colonel Burrard, R.E., F.R.S., Bt.-Colonel Renny-Tailyour, R.E., Lieut.-Colonel Gordon, I.A., Majors Ryder, D.S.O., R.E., Pirrie, I.A., and Coldstream, R.E., Captains Wood, Gunter, M.O'C. Tandy and Phillimore, and Lieutenants Baker, Campbell, and Chase, R.E.

Provincial Service.—Messrs. L. F. Berkeley, J. M. Kennedy, A. Ewing, M. Gastaud, A. B. Smart, H. G. Shaw, J. H. Nichol, Aulad Hossein, J. O. Greiff, W. Newland, E. C. J. Bond, Hanuman Prasad, Dhani Ram, J. R. Newland, Syed Zille Hasnain, C. West, E. B. West, H. D. W. Stotesbury, C. H. Tresham, V. D. B. Collins, M. M. Mudaliar, A. J. A. Drake and F. H. Grant.

Upper Subordinate Service.—Anantarao Dhondiba, Abdul Hakk, Dalbir Rai and Hayat Muhammad.

Surveyors, Draftsmen, etc.—Paras Ram, Hamid Gul, Ahmad Shah and Raj Ali of the Northern Circle and Ram Saran, Nain Singh, Pertab Singh, and B. V. Narain Rao of the Eastern Circle.

Head Quarters Offices.—Mr. T. A. Ferrier of the Mathematical Instrument office, Messrs. R. Taylor, F. R. Vandyke, R.E., S. Colquhoun, J. Vieux, J. D'Silva, Hingoo Jan and Nasir Ahmed of the Photo.-Litho. office, T. J. Jellicoe, and Suropada Roy Chowdhuri of the Drawing office, and Babu Chuni Lal Dey, Mr. E. A. Rundlett and Babu Norendra Nath Mukarji of the Clerical Establishment.

EXPENDITURE.

77. The total cost of the department for the survey year ending 30th September 1909 is R32,35,460, while that for the financial year ending 31st March 1909 is R33,81,569 against an estimated cost for 1909-10 of R33,90,750.

78. The actual expenditure on topographical surveys for the survey year 1908-09 amounts to R16,51,677 against R16,04,831 of the previous year. The expenditure on topographical surveys compares favourably with that of last year, as a reference to the areas surveyed will show. These are 42,600 square miles for the year under report against 35,968 square miles for 1907-08.

79. The cost of the trigonometrical and scientific parties is R4,17,542 against R4,13,283 of the preceding year. But this expenditure as in the case of last year is abnormal and temporary.

80. The cost of cantonment surveys amounts to R54,811 against R52,906 for 1907-08.

81. The expenditure on the local drawing offices, excluding the North-West Frontier and Simla Drawing offices, which are included in the expenditure of the office of the Superintendent, Northern Circle, amounts to R71,217 against R53,412 of the previous year.

82. The expenditure on cadastral operations in Burma amounts to R8,282 only against R1,57,847 of last year. The decrease is due to the abolition on the completion of its work of No. 7 Party that was employed there.

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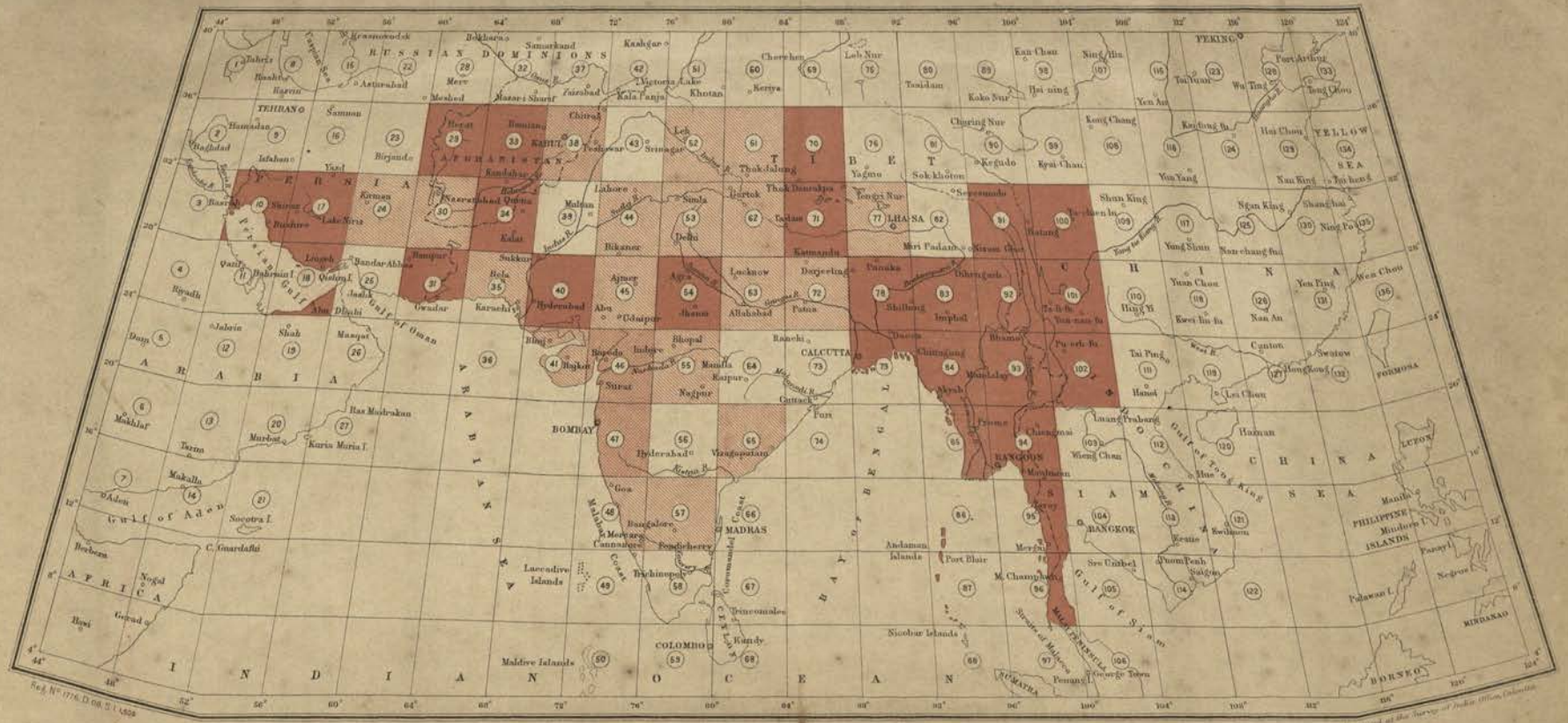
INDIA AND ADJACENT COUNTRIES SERIES

on the Scale of 1:1,000,000.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Fort Yukon
Fort Selkirk
Fort Halkett
Fort Nelson
Fort Vermilion
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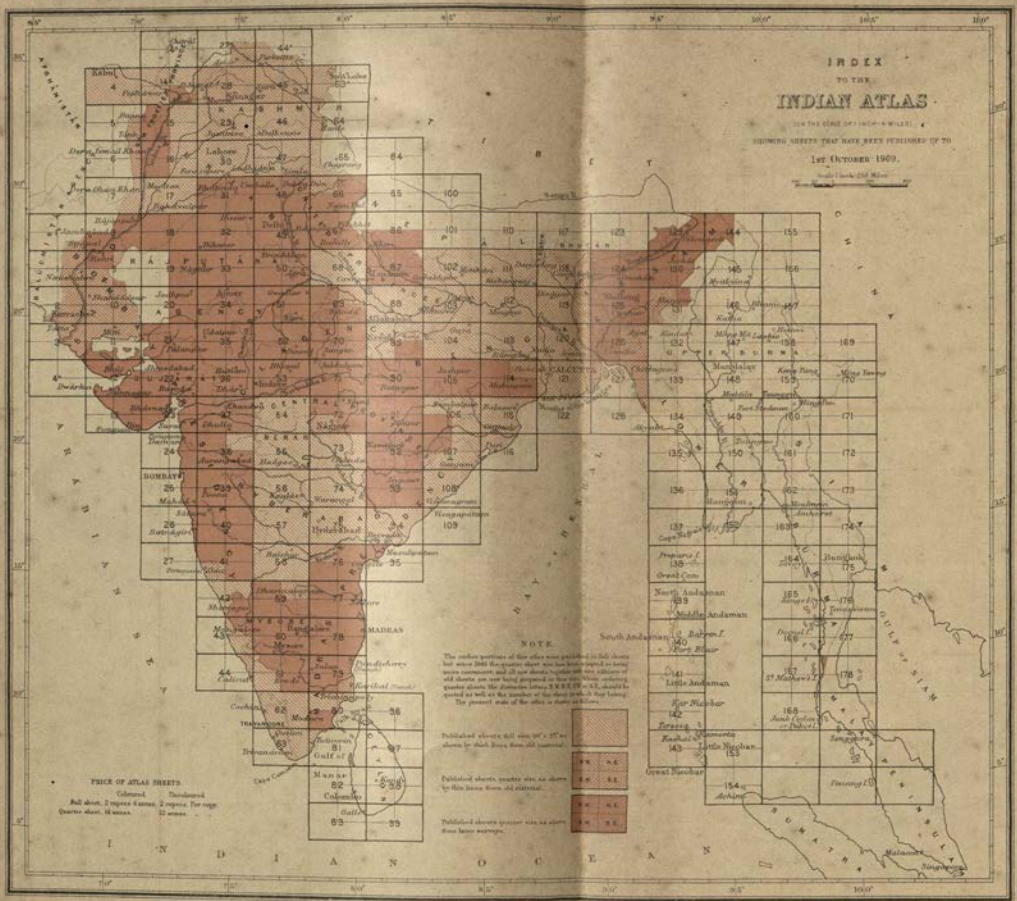
Fort Resolution
Fort Simpson



Reg. No. 1081 D., 08.—8. I.—600.
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Published under the direction of Colonel F. B. LONGE, R.E., Surveyor-General of India.
1909.

Litho., S. I. O., Calcutta.

PART II.

THE OPERATIONS OF FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 Party.*

83. The party was under the charge of Captain C. M. Browne, D.S.O., R.E., throughout the year under report and was divided into 5 principal and 4 secondary detachments.

Personnel.

Imperial Officers:

Captain C. M. Browne, D.S.O., R.E., in charge.
Mr. J. de G. Hunter, M.A.
Lieutenant E. B. Cardew, R.E.
Lieutenant G. F. T. Oakes, R.E.

Provincial Officers:

Messrs. C. H. Tresham, J. H. Johnson, Abdul Hai, V. D. B. Collins, F. W. Smith, G. A. Norman, B. T. Wyatt, Abdul Karim, K. S. Gopalachari, Mohan Lal Arora, V. P. Wainwright, C. S. McInnes.

The detachments were distributed as follows:—

Principal.

(*a*) Baluchistán detachment, working on the North Baluchistán series.

(*b*) North-West Frontier Province detachment, working on the North Baluchistán series.

(*c*) Burma (Shan States) detachment, on the Great Salween series.

(*d*) Burma (Upper) detachment, on the Upper Irrawaddy series.

(*e*) Kashmir detachment, on the new Kashmir series.

Secondary.

(*f*) Punjab detachment, on the traverse from Burála T. S. of the Jogí Tílá series to Shorkot h. s. and to Doráwálás.

(*g*) Assam detachment, on the selection and building of stations for the Khási hills secondary series.

(*h*) Lower Burma detachment, on the selection and building of stations for the Mawkmai secondary series.

(*i*) Upper Burma detachment, on the selection and building of stations for a secondary series along the meridian of 97°.

84. *Baluchistán detachment.*—The programme was to commence the North Baluchistán series from the side Zawa-Zibra of the Kalát Longitudinal series and to carry the triangulation as close to the western and northern borders of Baluchistán as practicable, closing on the Great Indus series if possible about latitude 32° 30′.

Lieutenant Oakes, R.E., was the observer and his detachment was formed mostly of newly recruited men with a nucleus of old men.

The detachment assembled at Mastung Road on the 16th May 1908 and left shortly after for the first station.

Observations were taken at Zawa and Zibra stations of the Kalát Longitudinal series and new stations were fixed at Koi Maran, Rastari Taing, Mashelak, Takatu, and Khwája Amrán.

An astronomical azimuth was observed at Mashelak (Lat. 30° 14′, Long. 66° 47′) and the difference found between the value so obtained and that computed from the triangulation was 1″·25, the sign of this difference was positive which is in accordance with other values found in that region.

*The statement on page 24 of the General Report of the Survey of India for 1907-08, that the computed values of azimuth are always larger than the astronomical values, was incorrect. In Baluchistán, the computed values are smaller, as has been well known for years. The persistency of their deficiency shows that our triangulation is being taken too far south. The incorrect statement in the report for 1907-08 was not due to any difference of opinion on the point, but to a clerical mistake that escaped detection.

The work was greatly hindered by dust haze which is prevalent in the summer, but the height of the stations made it impracticable to carry out the work in the winter.

Lieutenant Oakes carried the series up to the Toba plateau (Lat. 31°). The 8 completed triangles have an average error of 0″·41 and contain an area of 3,500 miles.

The side Koi Maran-Takatu is remarkable for being the longest side yet employed in the principal triangulation of India; its length is over 68 miles.

The detachment suffered considerably from malarial fever owing to the unusual amount of rain that fell. Work was closed at the end of November and the detachment recessed at Dehra Dún.

85. In August 1909, Mr. Tresham recommenced the work from the point where Lieutenant Oakes left off and up to date has fixed new stations at Padughar, Nari Shan Shela, Ghandak, Kand, Barsha, and Sakir.

The work is still in progress and consequently full details cannot be given in this year's report.

86. (*b*) *N.-W. Frontier Province detachment.*—Lieutenant Cardew, R.E., was the observer and his programme was to start the North Baluchistán series from the east and to carry it southwest over the Sulaimán range with the intention of joining up with the western part of the North Baluchistán series which had been begun in 1908. In addition to this a secondary series was to be run in order to fix the positions of Pakkalota, Jinighar and Darweshta Sar with accuracy in order to co-ordinate the triangulation in the Tochi and Kurram valleys.

87. The detachment was formed in the beginning of October 1908 and proceeded to Dera Ismail Khán and thence to Umar Khel, a station of the Great Indus series, but it was found that the triangulation could not be commenced from here as the station of Maidán had been destroyed. The series was therefore commenced from the sides Bani-Sakesar and Sakesar-Umar Khel, and a new station, which has been called Maidán II, was built near the site of the former one. On the hill a broken stone with a single dot cut on it was found covered with a cairn and Lieutenant Cardew's observations shew that it must have been almost exactly on the site of the former station; this is clearly shewn by the data of the two points given below.

I represents the data of the stone found from observations by Lieutenant Cardew.

II represents the data of Maidán H.S., from the synoptical volume of the Great Indus series.

	Lat.	Long.	Height.
I	32°51′5″·70	71°10′39″·99	4256·7 feet.
II	32°51′5″·70	71°10′40″·00	4275·0 „

88. Observations were made by Lieutenant Cardew at the following principal stations:—Bani, Sakesar, Umar Khel, Maidán No. II, Sheikh Ullah, Baindarra, and Shistarg; the last four being newly constructed stations; Shistarg is on Sheikh Budin, but is lower than either the principal or the subsidiary station, which formerly stood there.

Owing to the building of the cantonment both these had been lost.

Baindarra is near the site of an old station. From this station and from Shistarg only the back angles were observed as the station which was intended to be on Kaisarghar or the Takht-i-Sulaimán could not be built for political reasons.

Stations have been built on Ziárat, Surkund, and Sangarghar, but no observations have been taken and it is probable that a junction will now have to be made with the Great Indus series in the neighbourhood of Dera Gházi Khán.

Work was closed and the detachment returned to recess quarters at Mussooree in the middle of April.

89. The health of the men was on the whole good, but on first leaving Dera Ismail Khán many suffered from malarial fever which was very prevalent at that time in the district.

90. (*c*) *Burma* (*Shan States*) *detachment.*—The programme was to continue the Great Salween series from where it had been left off in 1907-08, but to bend the series to the eastward taking it across the Salween so as to include as much as possible of the country within the British border. Captain C. M. Browne

was the observer and the detachment assembled at Lashio on the 9th November, but heavy rain fell continually until almost the end of November and no work was possible until the first week in December.

New stations were fixed at Kiip Ma, Hpa Hpak, Paning Lung, Aunglawn, and Wán Wa.

An astronomical azimuth was observed at Kiip Ma and the difference between the value so obtained and that computed from the triangulation was 8″·60, the sign of this difference was negative which is in accordance with other values obtained in Burma.

In addition to the principal work Captain Browne fixed several of the topographical triangulation stations on which No. 2 party were basing their work.

The dust haze came on early in the year and work had to be closed on the 2nd of March, the detachment arriving at Lashio on the 21st March.

The country on the east of the Salween is very difficult to traverse, the hills being steep and roads practically non-existent. The health of the detachment was on the whole good although in the early part of the season fever was very prevalent and in the district small-pox was rife in the villages. A detailed statement of the outturn of work is given at the end of this report.

(*d*) *Upper Irrawaddy detachment.*—Mr. Smith with a small party of men selected and built the stations for this series from the initial side Song-Tangte of the Great Salween series up to Latitude 25°3′. Lieutenant Cardew, R.E., will, during the next field season, observe these stations and continue the selection and building. The series, which is at present trending northwards, will be deflected to the west in latitude 25° 30′ and will be eventually joined to the Mandalay series in longitude 96°.

(*e*) *Kashmir detachment.*—The programme for this detachment was to commence a series from the side Nerh-Khagriáná of the N.-W. Himalaya series and to carry it northward to connect up with the existing series in Kashmir. The detachment was formed in Dehra Dún in the middle of April and proceeded to Ráwalpindi. The observations were delayed by stations ahead not being ready in advance, and in July and August by the monsoon. Mr. Wyatt with a small party was detached to inspect and repair the stations of the old Kashmir series. This detachment is still in the field.

91. *Secondary triangulation.*

(*f*) In the Punjab a traverse was run with the Jäderin apparatus from Burála T. S. of the Jogí Tílá series to Shorkot h. s. and Doráwálá s. in order to co-ordinate the various traverses on which the topographical and revenue work of that district are based. The observers were Messrs. Tresham, Wyatt and McInnes. The difference found between the values thus obtained for Shorkot and Doráwálá and those given in the synoptical volume is considerable. Considering the accuracy of the methods used in the traverse it is more probable that the error lies in the secondary series of which Shorkot and Doráwálá are stations, unless the assumed length of "C" wire is in error. Comparative data are given below:—

I represents values obtained from the traverse.

II represents values from the synoptical volume.

Station.		Latitude.	Longitude.
Shorkot	(I)	30°49′ 57″·80	72°06′ 42″·30
	(II)	30°49′ 58″·51	72°06′ 43″·23
Doráwálá	(I)	30°27′ 51″·64	72°29′ 55″·725
	(II)	30°27′ 52″·60	72°29′ 56″·02

The total length of traverse was 118 miles and as a bench mark has been embedded every 6 miles the height of which was obtained by spirit levelling the line should be of permanent utility when the error has been located and distributed.

(*g*) In Assam Mr. Johnson commenced the selection and building of the stations for the Khási Hills secondary series, his detachment consisted of 22 men and field work was begun from Shillong in the beginning of November. Some difficulty was experienced in obtaining transport and supplies and the detachment

suffered a good deal from malarial fever but satisfactory progress was made in the work.

(*h*) In Lower Burma the selection and building of stations for the Mawkmai secondary series was carried from the starting side, (Letpataung-Suletaung) of the Mandalay meridional series, up to longitude 98°15′.

Two observers will be employed this field season and it is hoped that it will be completed at an early date. In the year under report Mr. Collins was in charge of the detachment and 28 stations were selected and built.

(*i*) In Upper Burma a small detachment under Mr. Mohan Lal Arora was employed on the selection and building of the stations for a secondary series in Bhamo district starting from the side Tangte-Taungkalat of the Great Salween series. The series is intended to run north along the meridian of 97° and Lieutenant Cardew will try to fix the stations already built from his stations of the Upper Irrawaddy series which will run parallel to the secondary series.

92. The party was inspected in recess by the Superintendent, Trigonometrical Surveys, during June 1909.

STATEMENT OF OUTTURN OF WORK.

Baluchistán detachment (North Baluchistán series).

Number of the Principal Stations at which observations were taken	8
Number of Principal Stations newly fixed	6
Length of new series in miles	100
Area of triangulation in square miles	3,500
Average triangular error of 8 triangles	0″·41
Value of Astronomical-Geodetic Azimuth at Mashelak	+1″·25

N.-W. Frontier detachment, North Baluchistán series.

Number of the Principal Stations at which observations were taken	7
„ secondary „ „	4
Number of the Principal Stations newly fixed	4
„ secondary „ „	4
Length of new series in miles Principal	50
„ „ „ secondary	50
Area of triangulation in square miles Principal	1,900
„ „ „ secondary	1,200
Average triangular error of 7 triangles of the Principal triangulation	0″·60
Average triangular error of 11 triangles of the secondary triangulation	3″·58
Value of Astronomical-Geodetic Azimuth at Umar Khel	+7″·66

Burma (Shan States) detachment (Great Salween series).

Number of the Principal stations at which observations were taken	8
Number of the Principal stations newly fixed	8
Length of new series in miles	100
Area of triangulation in square miles	4,200
Average triangular error of 9 triangles	5″·47
Value of Astronomical-Geodetic Azimuth at Kiip Ma	−8″·60

SECONDARY.

Punjab detachment.

Length of traverse in miles	118
No. of stations at which observations were taken	76
Number of Mark-stones embedded and fixed	22

SCIENTIFIC OPERATIONS.

GEODETIC.

STANDARD BAR COMPARISONS.

No. 22 Party.

93. During the field season of 1908-09 No. 22 Party was combined with No. 23 Party under Captain Cowie, R.E., and assisted that party in the pendulum operations. Previous to this, between the middle and end of November 1908, the party undertook the second series of comparisons of the Standard Bar A with the secondary standards I_B and I_S.

Personnel.

Imperial Officers:

Captain H McC. Cowie, R.E., in charge till 30th April 1909.

Lieutenant H. J. Couchman, R.E., in charge from 1st May 1909.

94. Standard Bar A had been sent, in 1908, to Sèvres for comparison with the International Metre. In the winter of 1907, before the Standard Bar left Dehra Dún, and again in November 1908, on its return from France, comparisons were made against the secondary Bars for the purpose of testing the constancy of its length during the interval between its departure from and its return to Dehra Dún. The result of the first series of comparisons and also the value of Bar A in terms of the International Metre formed the subject of the report submitted by the party for the year 1907-08.

Briefly, the results of the first set of comparisons were :—

I_S—A, at 62° F.=83·12 millionths of a yard.

I_B—A, at 62° F.=196·73 millionths of a yard.

And Bar A at 62° F.= 3047·996 millimetres.

95. The second series of comparisons was commenced on November 17th and concluded on December 1st, 1908. The observers were Captains H. H. Turner, R.E., and H. M. Cowie, R.E. The arrangement of the apparatus, and the procedure of the observations were the same as in the first series of comparisons. Twenty sets of comparisons were made of each of the bars I_B and I_S with Bar A.

During the observations involving I_S and A the temperature ranged from 61°·2 to 64°·9 F. and in the case of I_B and A from 57°·6 to 65°·5 F.

The results obtained were :—

I_S—A at 62° F.=81·13 millionths of a yard$\pm$0·36 m. y.

The mean temperature during the observations was 63°·74 F.

I_B—A at 62° F.=193·38 millionths of a yard$\pm$0·52 m. y.

The mean temperature during the observations was 61°·99 F.

The 1908 results differ from those of 1907 by 1·99 m. y. in the case of I_S—A and 3·55 m. y. for I_B—A.

These quantities correspond approximately to $\frac{1}{1,700,000}$ and $\frac{1}{1,000,000}$ of the length of Bar A and they show that it is improbable that any change took place in length of the Standard Bar A between the time it left Dehra Dún and the date of its return from Sèvres. Complete reliance may, consequently, be placed upon the value, stated above, of Bar A, in terms of the International Metre.

96. The health of the party throughout the year has been good.

97. The party was inspected by the Superintendent, Trigonometrical Surveys, during June 1909.

98. The programme for next season consists of latitude observations on the N. E. Quadrilateral, the stations to be visited lying approximately between Sítápur and Gorakhpur.

PENDULUM OPERATIONS.

No. 23 PARTY.

99. During the winter of 1908-09, as a first step towards the investigation of the variation of gravity in the northern portion of peninsular India, pendulum operations were carried out in the western tracts of the Sátpura hills and the Vindhyan plateau.

Personnel.

Imperial Officer:

Captain H. McC. Cowie, R.E., in charge.

Provincial Officer:

Mr. Hanuman Prasad.

100. The accompanying table shows the stations visited and the result of the observations. These latter depend on the base (Dehra Dún) values

$$g = 979{\cdot}063 \text{ dynes}$$
$$s = 0^{s}{\cdot}5072497$$

The quantity g is the observed value of gravity at the level of the station. g is derived from g by correcting for height above sea level only.

g''_0 is the final value of gravity at sea level, obtained after applying corrections for height and mass above sea level and for uneven terrain.

γ_0 is the theoretical value at sea level computed by Helmert's formula of 1884.

$$\gamma_0 = 978{\cdot}00\ (1 + 0{\cdot}005310 \sin^2\phi)$$

TABLE.

Station.	Latitude.	Height above mean sea level.	Observed value of gravity g.	g_0	Value of gravity at sea level g_0''	γ_0	$g_0''-\gamma_0$	$g_0-\gamma_0$
	° ′ ″	Feet.	Dynes.	Dynes.	Dynes.	Dynes.		
Ujjain . .	23 11 0	1,612	978·677	978·827	978·771	978·802	−0·031	+0·025
Mhow . .	22 33 10	1,903	978·620	978·797	978·730	978·763	−0.033	+0·034
Mukhtiára .	22 33 40	926	978·664	978·750	978·718	978·755	−0·035	−0·003
Mortakka .	22 13 20	756	978·703	978·757	978·737	978·743	−0·006	+0·014
Khandwá .	21 49 30	1,014	978·692	978·787	978·752	978·714	+0·038	+0·073
Asírgarh .	21 28 10	2,077	978·584	978·778	978·711	978·694	+0·017	+0·084
Jálgaon .	21 0 0	760	978·633	978·704	978·677	978·665	+0·012	+0·039
Amraotí .	20 55 50	1,123	978·609	978·714	978·675	978·665	+0·010	+0·049
Ellichpur .	21 18 20	1,314	978·618	978·740	978·694	978·685	+0·009	+0·055
Hoshangábád	22 45 0	1,002	978·719	978·812	978·777	978·773	+0·004	+0·039
Sháhpur .	22 11 30	1,286	978·663	978·783	978·738	978·743	−0·005	+0·040
Badnúr .	21 54 10	2,103	978·607	978·803	978·730	978·724	+0·006	+0·079

101. A noticeable feature of the results given in this table is that at seven stations situated at from 750 feet to 2,100 feet above sea level, excesses of gravity have been found. The work of past years has comprised observations at twenty-eight places at heights of over 750 feet, at none of which has gravity been proved to be in excess. In that the great majority of these twenty-eight stations are in extra-peninsular India, the results are interesting, as pointing to a dissimilarity of conditions prevailing in the crust in peninsular and extra-peninsular regions.

102. In the table above, the quantity $g_0-\gamma_0$ is the actual effect of masses surrounding the station, in excess or defect of the normal crust. Where complete compensation occurs, $g_0-\gamma_0$ should be *nil*. This condition is nearly attained at Mukhtiára. At the other stations an excess of mass is indicated. The average effect of excess of mass, as indicated by $g_0-\gamma_0$, taking all the stations into account, is almost exactly equal to the average attraction of the masses above sea level, calculated on the assumption that the density is 2·8. From this it may be inferred that in the portion of peninsular India under consideration, treated as a whole, the degree of compensation of visible masses is very small.

103. The determination of the clock rate was undertaken by Mr. Hanuman Prasad. The results were thoroughly satisfactory, the average p. e. of the daily rate deduced from observations on two successive nights being $\pm 0^{s}{\cdot}012$.

104. The times of vibration of the mean pendulum, at Dehra Dún, were

in December 1908 $s = 0^{s}{\cdot}5072499$
May 1909 $s = 0^{s}{\cdot}5072496$

The mean value, $0^{s}{\cdot}5072497$ was accepted as representative of the period December 1908 to May 1909.

Since January 1904, the date of the commencement of operations with the half-seconds pendulums, the length of the mean pendulum has decreased, the time of vibration having changed by about 23 in the seventh decimal place of a second.

Of the individual pendulums, the times of Nos. 137, 138, 139 have all changed in a similar way and by about like amounts, all showing a decrease. No. 140, on the other hand, appears to have altered but little, the indications not being very decided, and the change would seem to tend to an increase of the time of vibration.

On the assumption that these alterations of length are due to molecular influences, it would be natural to suppose that with increasing age of the pendulums there would be a gradual approach to molecular stability, and that consequently, for equal periods of time, the absolute amounts of change in length would become smaller and smaller. If the course of the variations of length were represented by a curve, we should expect, dividing this curve into three major periods, that the first period, representing the earlier life of the pendulum would exhibit changes comparatively large and varying little in value; that after passing through an intermediate period, during which the changes corresponding to equal intervals of time decreased rapidly in amount, we should reach the last period where the changes from time to time were infinitely small and approximately equal. A consideration of the Indian pendulums shews that they must still be considered to be in the first period, and it is a matter for surprise that this should have lasted for as long as five years.

Further particulars of the changes in the times of vibration are given in the narrative report submitted by the officer in charge of the party.

105. The health of the party was good.

106. The party was inspected by the Superintendent, Trigonometrical Surveys, during June 1909.

107. The future work of the party will be the gradual extensions of the gravimetric survey to the east and north, over Rájputána, the Vindhya plateau and the Sátpurá hills to the Gangetic plain. In the season of 1909-10 pendulum operations will be undertaken in the eastern Sátpurá hill tracts.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

Personnel.

Imperial Officer:

Mr. C. F. Erskine, in charge.

Provincial Officers:

Messrs. J. P. Barker, H. G. Shaw, E. H. Corridon, Syed Zille Hasnain A. M. Talati, O. . Pushong, P. N. Sur, D. H. Luxa, T. F. Kitchen and H. St. J. Kenny.

108. Mr. C. F. Erskine held charge of the party throughout the year.

Subordinate Establishment:

1 Surveyor, 24 Computers and Recorders, 2 Artificers and 3 Observatory Clerks.

Tidal Operations.

109. Observations were taken by means of self-registering tide-gauges during the year at the stations enumerated in the following list:—

Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1. *Aden*	1879	Still working	29	
2. *Karáchi*	1868*	1880*	13*	*Small tide-gauge working.
	1881	Still working	28 } 41	
3. *Bombay (Apollo Bandar)*	1878	" "	31	
4. *Bombay (Prince's Dock)*	1888	" "	21	Property of Port Trust.
5. *Madras*	1880	1890	10	
	restarted 1895	Still working	14 } 24	
6. *Kidderpore*	1881	" "	28	
7. *Rangoon*	1880	" "	29	
8. *Port Blair*	1880	" "	29	
9. *Moulmein*	1880	1886	6	
	restarted 1909	Still working		

110. In addition to the above, readings to tide-poles were taken at Bhávnagar, Chittagong and Akyab.

111. The nine tidal observatories at work were inspected during the year, and the registrations have been satisfactory.

112. In the following tables are given the annual and decadal percentages of the predicted time and height errors of high and low waters at open coast and riverain stations:—

Percentage of errors in Predicted Times and Heights at open coast stations from automatic registrations.

Year.	Number of Stations.	In Time.		In Height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1899	9	74	66	95	95	93	92
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
1905	7	82	79	96	95	96	97
1906	6	85	81	96	97	94	95
1907	6	84	83	98	98	98	99
1908	6	84	84	98	97	99	99
Average of 10 years	8	78	73	95	95	95	95

Percentage of errors in Predicted Times and Heights at riverain stations from automatic registrations.

Year.	Number of Stations.	In Time.		In Height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
1905	2	52	62	72	57	94	92
1906	2	59	53	74	64	92	95
1907	2	58	47	78	60	96	90
1908	2	58	52	77	60	97	92
Average of 10 years	2	57	58	74	61	93	91

113. At Moulmein a new observatory was erected in August 1908, on a site close to the old one which was dismantled in 1886. The tide-gauge was duly installed and registrations were commenced on the 1st of January 1909. The true zero of the gauge is identical with that adopted in 1880, when the gauge was first started. The results derived from the observations which are now being registered, will serve as a check on the accuracy of the predictions already published.

Levelling Operations.

114. Three detachments were employed on the levelling operations during the past season.

115. No. 1 Levelling detachment connected the standard bench-marks at Sátára, Belgaum, Bangalore, Salem, Trichinopoly, Negapatam, Madura, Tinnevelly, Calicut, Bijápur and Akola and carried out a line of levels from

Secunderábád to Warora, connecting the standard bench-marks at Secunderábád, Trimulgherry and Bolárum. The outturn amounted to 332·2 miles. The field season commenced on 8th October 1908 and ended on 15th April 1909.

116. No. 2 Levelling detachment levelled from Nagaur to Ahmadábád *viâ* Jodhpur and Pálanpur, connecting the standard bench-marks at Jodhpur and Ahmadábád. A branch line of levels was run from Pálanpur to Deesa, connecting the standard bench-mark at Deesa. The standard bench-mark at Roorkee was then connected and a line of levels was carried from Hardwár to Dehra Dún. The total outturn of levelling was 450·5 miles. The duration of field season was from the 3rd October 1908 to 9th April 1909.

117. No. 3 Levelling detachment was employed on levelling operations from Katni *viâ* Jubbulpore and Seoni to Nágpur and from Wardha to Warora. The standard bench-marks at Jubbulpore, Nágpur, Hinganghát, Saugor, Raipur, Biláspur and Sambalpur were also connected. The outturn amounted to 302·3 miles. The field season lasted from the 14th October 1908 to 16th April 1909.

118. During the past field season three important lines of levels which were undertaken principally to break up the larger level circuits were completed, *viz.*, (1) from Ferozepore across Rájputána to Ahmadábád, (2) from Katni *viâ* Jubbulpore and Seoni to Nágpur, and (3) from Wardha *viâ* Warora and Nirmal to Secunderábád.

119. During the past year 16 standard bench-marks were erected and 56 connected, 32 are under construction and 39 have been proposed for erection.

120. The health of the members of the levelling detachments was generally far from good. At the commencement of the field season a large percentage of the establishment suffered from malarial fever, but later on the health of the men improved, and in the latter portion of the season was on the whole good.

121. The Superintendent, Trigonometrical Surveys, inspected the party in May 1909.

PROGRAMME FOR NEXT YEAR.

122. Tidal operations during the coming year will be confined to the 9 observatories now working.

123. During the coming field season No. 1 Levelling detachment will be employed in Burma on new levelling from Wuntho to Myitkyina, and revision levelling from Pyinmana to Rangoon, and the connection of the standard bench-marks at Rangoon, Pegu, Toungoo, Mandalay, Shwebo, Meiktila, Magwè, Wuntho and Myitkyina. No. 2 Levelling detachment will be employed on levelling from (1) Siliguri to Tindhária, (2) Bareilly to Naini Tál, (3) Ambála to Solon, (4) Hardwár to Lansdowne, and the connection of standard bench-marks at Nellore, Bezwáda, Cocanáda, Vizagapatam, Berhampur, Cuttack, Balasore, Burdwán, Gauháti, Dhubri, Dinájpur, Purnea, Bhágalpur, Patna (Bankipore), Muzaffarpur, Motíhári, Rewah and Lucknow (new).

No. 3 Levelling detachment will be employed on levelling from (1) Laluwali T. S. near Khánpur to Rohri, (2) Shikárpur to Jacobábád, (3) Páli h. s. to Godhra, (4) Lahore to Dharmkot, and the connection of standard bench-marks at Sadikganj, Baháwalpur, Khánpur, Sukkur, Jacobábád, Hyderábád (Sind), Karáchi, Godhra, Baroda, Rájkot, Surat, Dhúlia, Mhow and Bhopál.

Tabular Statement of outturn of work of Levelling Detachments Nos. 1, 2 and 3.

	Number of miles of Double Levelling, including Branch Lines.	NUMBER OF BENCH-MARKS CONNECTED.							
		Old.			Standard.	Embedded.	Inscribed.	G. T. Survey.	Irrigation, Railway and other Departments.
		Standard.	Embedded.	Inscribed.					
Levelling Detachment No. 1	332	...	14	36	14	25	185	2	25
Ditto No. 2	450	1	2	9	4	41	297	5	2
Ditto No. 3	302	...	7	49	7	24	143	6	7
TOTAL	1,084	1	23	94	25	90	625	13	34

MAGNETIC OPERATIONS.

No. 26 Party.

124. The party remained in charge of Lieut. H. J. Couchman, R.E., until 31st March 1909, when he was relieved by Captain R. H. Thomas, R.E., on return from furlough.

Personnel.

Imperial Officers:

Captain R. H. Thomas, R.E., in charge from 1st April 1909.
Lieutenant H. J. Couchman, R.E., till 30th April 1909 (in charge till 31st March 1909).
Lieutenant H. T. Morshead, R.E., till 31st March 1909.

Provincial Officers:

Messrs. E. C. J. Bond, H. P. D. Morton, R. P. Ray, N. R. Mazumdar and R. B. Mathur.

Subordinate Establishments:

2 Observers, 13 Recorders, 1 Computer, 2 Surveyors and 1 Writer.

125. *Work of the field detachments.*—During the year under report field operations were continued by four detachments.

Two of these were employed in Burma in completing the areas allotted to the preliminary survey: the two remaining commenced the detailed survey by the examination of several obviously disturbed areas.

The field season commenced on the 26th October 1908, and the party proceeded to recess quarters on May 3rd, 1908.

126. *Work of the Imperial Officers.*—The officer in charge with his assistant (Lieut. H. T. Morshead, R.E., temporarily posted to the party) visited all the repeat stations, 22 in number, and also re-observed at a number of old field stations. Comparative observations were also taken at the four survey base stations and at Alíbág to determine the differences from the survey standard at Dehra Dún.

127. *Total work to date.*—Forty-one new stations of the preliminary survey were occupied: the total number of stations of the preliminary survey thus becomes 1,255. Twenty-six old field stations were re-occupied, making 57 in all, at which observations have been repeated.

A new repeat station was established at Port Blair: this had long been considered advisable, but no opportunity had occurred before.

One hundred and twenty-two stations were occupied in the detailed survey.

128. *Work during recess.*—During the recess season the computations of the field work and the reduction and tabulation of the base station results for 1908 have been completed.

The triangulation carried out in 1907-08 by Mr. Morton, of this party, in connection with the Chin-Lushai-Arakan Boundary Survey, was re-computed and the results submitted to the Superintendent in charge, Burma Surveys.

The correction of the horizontal force and declination observations for diurnal variation and instrumental differences in declination is in hand, the repeat stations and re-observed field stations being dealt with in the first instance.

With regard to the correction for instrumental differences in H. F., the whole question is now under investigation, the main points being considered are—

(*a*) Whether any correction should be made to the standard on account of change in the moment of inertia.

(*b*) Whether the discrepancies in different seasons in the differences from the standard can be eliminated by using for the distribution factor $\log\left(1-\frac{p}{r^2}-\frac{q}{r^4}\right)$ instead of $\log\left(1-\frac{p}{r^2}\right)$.

As regards (*a*), observations for the moment of inertia have been taken with the standard magnet No. 17 every year, and, allowing for the change in weight of inertia bar No. 17 (see Narrative Report for 1904-05), there appears to be a gradual and regular fall in the value, corresponding in 1908 to a correction of 19γ in H. F.

With regard to (*b*), the expression for the connection between M, H, the deflecting distance (r) and the angle of deflection (u) is—

$$\frac{H}{M}=\frac{2}{r^3 \sin u}\left(1+\frac{p}{r^2}+\frac{q}{r^4}+ \ldots\right)$$

where p and q are the distribution constants. The expression $1-\frac{p}{r^2}$ which is now employed is obtained on the assumption that $\frac{q}{r^4}$ is negligible: this is, however

far from being the case; the correction to the observed value of H. F. varying from 0 to +60γ at Dehra Dún with various instruments. The magnitude of the correction, moreover, is not a constant for any particular instrument, but may vary within considerable limits from time to time; there is further considerable liability to sudden change when there is a sharp drop in the magnetic moment, though the distribution factor now applied may show little or no alteration.

The investigation has necessitated considerable computation, but a preliminary reduction of the instrumental differences correcting as above gave promising results, and the investigation will therefore be continued. It may be mentioned that this investigation has considerable bearing on the question of H. F. disturbance corrections, owing to the resulting changes in the monthly base lines: it will also affect the secular change values, since various instruments have been used at the repeat stations and re-observed field stations.

An approximate reduction of the H_c F. observations at repeat stations and re-observed field stations has also been done: it has indicated that the present number of repeat stations is far too small for the correct appreciation of the annual change, and the present policy of re-observing at a number of old field stations will, as far as time permits, be continued.

During the year values of magnetic declination were supplied as under :—

For standard 1-inch maps	433
For degree sheets	26
To private individuals	34
TOTAL	493

129. *The base stations.*—The magnetographs have given good results during the year.

Serious trouble has, however, been experienced in Dehra Dún observatory owing to the heavy rainfall; it was found impossible to prevent water forcing its way into the magnetograph room, and finally, on August 15th, it was deemed advisable to remove the instruments.

The H. F. and declination magnetographs had been working since January 1903 with only minor interruptions, while the V. F. instrument was erected in 1905. The instruments were re-erected on September 11th and 12th, but the break of record is a great misfortune.

In the Narrative Report of 1902-03 an account is given of the measures taken to obviate a recurrence of the flooding of the observatory in the autumn of 1901, but the experience of the last few years has shown that the hopes then expressed were unduly optimistic.

In 1904-06 water entered the magnetograph room: in 1905-07 the rainfall was less than the normal, and, though in 1908 the total rainfall was heavy, the room remained practically dry, as there was no prolonged period of heavy rainfall as in the present year.

After three or four days' heavy rain the subsoil becomes waterlogged, water increases in the catchment pit faster than it can be pumped out, and the walls and floor are subjected to a head of 10 feet or more, a pressure which they are ill-calculated to resist.

Pumping with two pumps had been going on day and night for over a week before the instruments were removed, yet at the time of their removal, the water had risen to within an inch of the top of the driving clock pillar, while subsequently on the same day this pillar was submerged: at the time the water level in the catchment pit was 11 feet above the level of the floor of the observatory.

130. *Mean values of magnetic elements.*—The mean values of the magnetic elements at the four survey base stations for 1908 are as follows :—

Dehra Dún	Lat. 30°19′	Long. 78° 3′
Declination	2° 36′·7 E.	
Dip.	43° 42′·2 N.	
H. F.	·33293 C. G. S.	
V. F.	·31819 „	
Barrackpore	Lat. 22° 46′	Long. 88° 22′
Declination	1° 5′·7 E.	
Dip.	30° 34′·5 N.	

H. F.			·37031 C. G. S.
V. F.			·22038 „
Toungoo	Lat. 18° 36′	Long. 96° 27′	
Declination			0° 34′·4 E.
Dip.			23° 2′ N.
H. F.			·38763 C. G. S.
V. F.			·16479 „
Kodaikánal	Lat. 10° 14′	Long. 77° 28′	
Declination			0° 45′·4 W.
Dip.			3°33′·2 N.
H. F.			·37434 C. G. S.
V. F.			·02324 „

131. A table showing the approximate preliminary values (uncorrected) at the field and repeat stations in 1908-09 is appended, together with a reference index chart showing all the stations of observation to date.

132. *Health of party.*—The health of the party was on the whole satisfactory, though the detachments working in Burma at times suffered severely from malaria.

133. *Inspection visits.*—The party was inspected in recess by the Superintendent, Trigonometrical Surveys, on June 24th, 1909.

134. *Work projected for 1909-10.*—During the next field season the detailed survey will be continued on the same lines as last year by two detachments.

Two detachments will be employed in re-observing at old field stations, particularly in the area lying between Lat. 16°—19° and Long. 73°—78°, where the secular change in H. F. appears to be particularly abnormal.

The computing section in Dehra Dún will continue the reduction of the preliminary survey, in addition to its normal work of computing and tabulating the base station results.

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season 1908-09.

DETAIL SURVEY STATION.

Serial No.	Name of Station.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
		° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
1D	Mhow	22 33 0	75 45 0	30 1	E 0 49	0·3646	H. is derived from Mean M° throughout.
2D	Mánpur	22 25 50	75 36 40	29 23	„ 0 42	0·3670	
3D	Gujri	22 18 40	75 30 40	29 52	„ 1 0	0·3639	
4D	Lunera	22 27 40	75 25 20	30 2	„ 0 52	0·3647	
5D	Nímkhera	22 26 10	75 11 30	29 57	„ 0 55	0·3648	
6D	Deola	22 19 0	75 5 30	29 29	„ 1 35	0·3627	
7D	Liwáni	22 18 50	75 18 30	29 43	„ 1 4	0·3631	
8D	Bákáner	22 11 10	75 9 30	29 16	„ 1 4	0·3629	
9D	Dharmpuri	22 9 0	75 21 10	28 3	W 0 4	0·3886	
10D	„ A	22 10 0	75 19 30	30 50	E 0 33	0·3532	
11D	„ B	22 9 50	75 20 40	31 43	„ 0 47	0·3485	
12D	„ C	22 9 20	75 20 50	29 50	E 0 46	0·3601	
13D	Degáwa	22 10 10	75 22 10	29 9	„ 1 24	0·3618	
14D	Dasora	22 10 50	75 20 50	31 24	„ 1 13	0·3583	
15D	Dhegda	22 12 20	75 21 50	29 8	„ 0 58	0·3643	
16D	Chota Pípliá	22 11 20	75 18 40	29 26	„ 0 52	0·3622	
17D	Khárpura	22 9 10	75 17 30	29 35	„ 0 49	0·3604	
18D	Mahápura	22 8 40	75 14 50	30 51	„ 0 43	0·3596	
19D	Dédgaon	22 10 30	75 15 30	29 6	„ 0 53	0·3714	
20D	Baikhera	22 12 10	25 12 50	28 52	„ 0 46	0·3667	
21D	Potwár	22 8 20	75 11 30	30 59	„ 1 27	0·3562	
22D	Brahmangaon	22 6 0	75 16 50	30 30	„ 0 56	0·3597	
23D	Balgaon No. 1	22 3 20	75 17 20	30 11	„ 0 32	0·3459	
24D	Khurrampur	22 1 10	75 21 0	28 45	„ 0 42	0·3649	
25D	Thíkri	22 4 10	75 24 10	29 47	„ 1 1	0·3604	
26D	Abáli	22 5 20	75 20 50	33 14	„ 0 44	0·3356	
27D	Chichili	22 7 40	75 23 50	29 58	„ 1 10	0·3668	
28D	Khalgsháṭ A	22 8 30	75 27 10	31 12	„ 0 53	0·3578	
29D	Dhámnod	22 11 30	75 27 50	29 23	„ 1 10	0·3635	
30D	Regwán	22 6 0	75 29 40	27 33	„ 0 18	0·3744	
31D	Dolání	22 2 20	75 28 40	28 38	„ 0 31	0·3694	
32D	Dángri	22 0 0	75 14 40	28 48	„ 0 38	0·3665	
33D	Talwára	22 4 40	75 12 10	30 52	„ 0 26	0·3583	
34D	Kirmoi	22 5 30	75 8 50	30 46	„ 1 25	0·3623	
35D	Mundiakheri	22 2 30	75 8 10	31 8	„ 1 12	0·3649	
36D	Salkhera	21 54 10	75 9 30	31 4	„ 1 18	0·3556	

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season 1908-09 – contd.

DETAIL SURVEY STATION—*contd.*

Serial No.	Name of Station.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
		° ′ ″	° ′ ″	° ′	° ′	C G S.	
37D	Piprí	21 57 10	75 11 40	28 51	E 1 10	0·3663	
38D	Danund	21 53 20	75 5 0	28 4	„ 1 22	0·3552	
39D	Raita	21 51 50	75 8 30	30 20	„ 0 39	0·3634	
40D	Balgaon No. 2	21 51 20	75 12 40	28 14	„ 0 11	0·3773	
41D	Nágalwári	21 45 30	75 15 40	29 30	„ 1 12	0·3641	
42D	Kheri	21 52 30	75 20 50	28 42	„ 1 0	0·3643	
43D	Likhi	21 55 20	75 27 50	30 19	„ 0 40	0·3619	
44D	Khargon	21 50 0	75 36 0	29 34	„ 0 41	0·3657	
45D	Sirkandi	21 44 20	75 27 30	29 21	„ 0 33	0·3631	
46D	Dhúlkot	21 36 30	75 33 10	28 49	„ 0 45	0·3631	
47D	Pipal Jopa	21 33 10	75 41 20	27 49	„ 0 41	0·3690	
48D	Islámpura	21 39 10	75 37 50	28 7	„ 0 57	0·3683	
49D	Ghári	21 39 40	75 43 50	28 28	„ 0 33	0·3672	
50D	Mogargaon	21 42 0	75 49 30	28 31	„ 1 19	0·3640	
51D	Bistán A	21 42 0	75 40 10	27 59	„ 0 38	0·3690	
52D	Deoli	21 45 10	75 33 30	29 34	„ 0 28	0·3686	
53D	Piparker	21 45 20	75 39 20	25 25	W 0 31	0·3885	
54D	Julwána	21 48 40	75 44 0	30 22	E 1 2	0·3614	
55D	Sultánpur	21 52 10	75 47 0	29 30	„ 0 45	0·3653	
56D	Lohári	21 57 40	75 37 50	28 4	„ 0 56	0·3667	
57D	Kamuthwára	22 2 20	75 47 10	30 27	„ 0 28	0·3650	
58D	Kaori	22 2 50	75 41 40	29 54	„ 0 51	0·3631	
59D	Dogaonwa	22 7 20	75 38 40	29 45	„ 0 49	0·3634	
60D	Chamu	26 39 20	72 34 50	37 38	„ 1 54	0·3439	
61D	Rájabás	26 34 30	72 28 50	37 14	„ 1 49	0·3448	
62D	Loharan	26 39 30	72 22 20	36 58	„ 0 47	0·3424	
63D	Gilankor	26 45 50	72 26 40	37 37	„ 1 55	0·3435	
64D	Pílu	26 50 50	72 26 20	37 56	„ 1 42	0·3415	
65D	Kolu	26 55 0	72 18 10	37 53	„ 2 2	0·3412	
66D	Sagra	26 47 20	72 17 20	36 57	„ 1 25	0·3404	
67D	Márla No. 1	26 51 10	72 13 0	36 45	„ 1 9	0·3375	
68D	Untwália	26 45 10	72 12 10	39 37	W 0 38	0·3345	
69D	Chansuma	26 46 10	72 9 10	40 9	E 1 2	0·3368	
70D	Márla No. 2	26 48 40	72 12 30	41 20	„ 0 53	0·3297	
71D	Kaláo	26 39 40	72 6 30	39 9	„ 2 24	0·3410	
72D	Bhurkia	26 43 0	72 10 10	39 45	„ 0 58	0·3404	
73D	Shetráwa	26 35 50	72 17 20	36 28	W 2 1	0·3500	
74D	Rainsar	26 29 0	72 18 50	36 59	E 0 36	0·3499	
75D	Soália	26 26 50	72 12 40	37 37	„ 1 1	0·3398	
76D	Somésar	26 34 20	72 10 0	37 56	„ 1 33	0·3513	
77D	Jethania	26 37 50	72 11 40	39 17	„ 0 18	0·3465	
78D	Rataria	26 36 50	72 1 50	38 34	„ 2 44	0·3416	
79D	Sardar-Singh-ki-Dhoni	26 38 20	71 48 50	35 17	„ 3 19	0·3297	
80D	Dhursar	26 49 30	72 0 10	40 6	„ 2 25	0·3347	
81D	Marwa	26 45 0	71 54 10	38 6	„ 4 45	0·3552	
82D	Modadri	26 49 50	71 44 10	37 19	„ 2 19	0·3474	
83D	Udhánia	26 58 0	71 43 10	37 35	„ 2 17	0·3405	
84D	Rathora	27 6 40	71 53 10	37 24	„ 2 7	0·3439	
85D	Khara	27 1 50	72 7 30	38 7	„ 1 51	0·3414	
86D	Bengti (Bari)	27 9 10	72 10 30	38 31	„ 2 46	0·3429	
87D	Jalóra	26 59 40	72 24 30	38 15	„ 2 12	0·3417	
88D	Uparli	27 3 10	72 16 0	38 20	„ 2 11	0·3439	
89D	Dádu	26 55 10	72 8 0	38 5	„ 1 38	0·3367	
90D	Ékka	26 57 30	71 59 30	38 23	„ 1 55	0·3310	
91D	Dédia	26 50 30	72 6 30	39 57	„ 1 1	0·3280	
92D	Moru	26 42 10	71 58 30	39 20	„ 1 22	0·3475	
93D	Shetráwa (*a*)	26 35 50	72 17 20	36 9	W 0 12	0·3463	
94D	Garawad	24 14 20	75 10 20	34 23	E 1 31	0·3562	
95D	Jíran	24 18 40	74 53 30	33 35	„ 2 9	0·3542	
96D	Thara	24 11 0	74 51 20	33 12	„ 1 24	0·3555	
97D	Palsoda	24 21 40	74 59 20	33 22	„ 1 0	0·3552	
98D	Neemuch	24 27 0	74 52 50	34 18	„ 1 11	0·3551	
99D	Beri	24 23 10	74 45 10	33 51	„ 1 21	0·3540	
100D	Bamora	24 24 50	74 34 10	33 57	„ 1 41	0·3547	
101D	Bári	24 30 50	74 39 40	34 46	„ 1 39	0·3544	
102D	Badésar	24 41 10	74 30 30	34 29	„ 1 49	0·3522	
103D	Bhadaura	24 42 40	74 21 50	34 21	„ 1 50	0·3524	
104D	Akola	24 45 0	74 12 0	34 13	„ 1 38	0·3523	
105D	Newánia	24 38 20	74 3 0	34 1	„ 1 33	0·3525	
106D	Hita	24 33 40	74 11 40	34 15	„ 1 49	0·3506	
107D	Padampurá	24 34 50	74 20 0	34 5	„ 1 51	0·3530	
108D	Ishanuja	24 32 0	74 29 20	34 12	„ 1 42	0·3535	
109D	Pachar	24 24 20	74 25 50	33 49	„ 1 38	0·3538	
110D	Bhairvi	24 19 40	74 34 30	33 46	„ 1 39	0·3552	
111D	Barol	24 17 50	74 43 20	33 43	„ 1 27	0·3550	

H. is derived from Mean M° throughout.

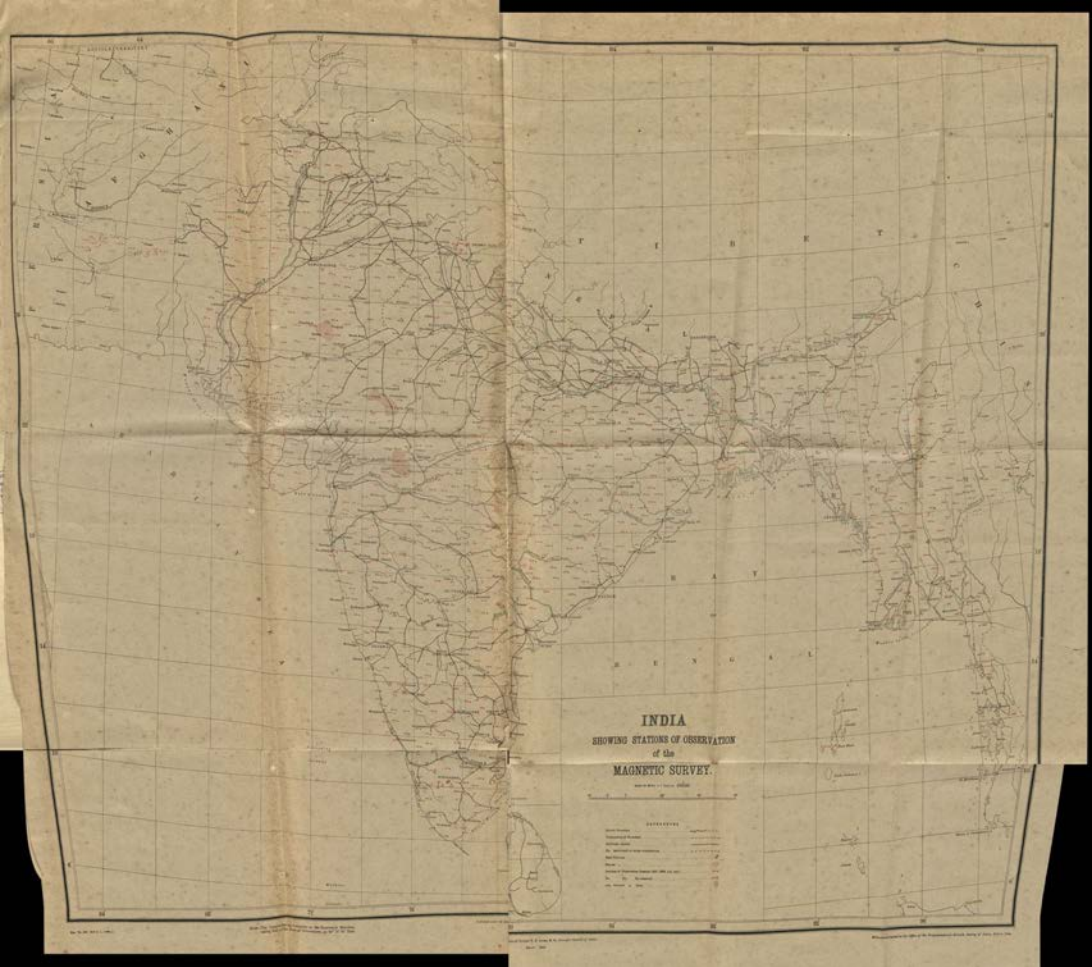
Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season 1908-09—contd.

DETAIL SURVEY STATION—*concld.*

Serial No.	Name of Station.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
		° ′ ″	° ′ ″	′ °	° ′	C. G. S.	
112D	Barawarda	24 11 30	74 42 0	33 23	E 1 27	0·3555	H. is derived from Mean M°. throughout.
113D	Bamotar	24 4 20	74 45 20	33 21	„ 0 58	0·3555	
114D	Kalianpura	24 4 30	74 54 20	33 21	„ 1 16	0·3555	
115D	Khiraut	23 57 20	74 48 0	33 23	„ 1 1	0·3508	
116D	Sâgthali	23 49 10	74 48 10	32 52	„ 1 18	0·3564	
117D	Dhanderio	23 50 10	74 56 40	32 42	„ 1 23	0·3564	
118D	Jawâsia	23 57 30	74 52 30	33 9	„ 1 10	0·3556	
119D	Mandsaur	24 4 10	75 4 40	34 1	„ 1 15	0·3637	
120D	Sunti	24 6 0	75 13 50	33 4	„ 1 18	0·3582	
121D	Barwan	23 56 50	75 11 0	32 55	„ 0 58	0·3573	
122D	Kachnara	23 50 30	75 6 20	32 30	„ 1 2	0·3553	

FIELD STATIONS.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
1215	Kyauktaw	20/91 3	20 50 30	92 58 40	26 52	E 0 39	0·3818	H. is derived from Mean M°. throughout.
1216	Paletwa	22/91 8	21 18 10	92 51 40	27 50	„ 0 45	0·3807	
1217	Kaletwa	„ 9	21 44 0	92 47 50	28 39	„ 0 49	0·3798	
1218	Kyaukpyu	20/92 12	19 26 0	93 33 30	23 58	„ 0 35	0·3862	
1219	Ramree	„ 13	19 5 50	93 52 0	23 20	„ 0 34	0·3874	
1220	Cheduba	13/94 1	18 51 10	93 43 30	22 41	„ 0 34	0·3882	
1221	Sandoway	„ 2	18 27 50	94 22 0	21 53	„ 0 32	0·3889	
1222	Kyeintali	„ 3	18 0 0	94 29 10	20 56	„ 0 29	0·3898	
1223	Gwa	„ 4	17 35 20	94 34 50	20 1	„ 0 24	0·3907	
1224	Bawmi	„ 5	17 18 30	94 34 40	19 22	„ 0 25	0·3912	
1225	Taseng	16/95 2	16 54 20	94 23 40	18 27	„ 0 23	0·3911	
1226	Ngo-yôn-kaung	„ 3	16 30 20	94 18 0	17 33	„ 0 20	0·3923	
1227	Kâbaung-hmau	„ 4	15 59 50	94 16 40	16 17	„ 0 19	0·3931	
1228	Labutta	„ 5	16 8 40	94 45 20	16 48	„ 0 38	0·3936	
1229	Wakéma	18/96 2	16 36 0	95 10 10	17 50	„ 0 36	0·3925	
1230	Mya-tha	„ 3	16 14 10	95 17 0	17 4	„ 0 24	0·3924	
1231	Ma-ubin	„ 4	16 44 20	95 39 10	18 13	„ 0 24	0·3916	
1232	Pyapôn	„ 5	16 17 10	95 40 50	17 15	„ 0 23	0·3925	
1233	Kadôn-kani	„ 6	15 40 40	95 12 50	16 17	„ 0 19	0·3932	
1234	Vandoon	18/95 11	17 2 50	95 38 10	18 55	„ 0 27	0·3925	
1235	Me-za-li-gôn	„ 12	17 52 50	95 14 0	20 39	„ 0 27	0·3909	
1236	Petyè	„ 13	18 8 30	95 8 20	21 33	„ 0 29	0·3894	
1237	Tabee	14/96 6	18 38 20	94 40 20	22 16	„ 0 32	0·3888	
1238	Taungup	„ 7	18 51 40	94 14 50	22 42	„ 0 33	0·3884	
1239	Mai	22/92 14	19 17 10	94 8 0	23 44	„ 0 35	0·3873	
1240	Sakamau	„ 15	19 38 50	94 0 10	24 23	„ 0 36	0·3863	
1241	Thanoaya	18/93 3	16 7 20	98 2 10	16 56	„ 0 35	0·3936	
1242	Kyunghaung	„ 4	15 32 10	98 15 20	15 37	„ 0 31	0·3942	
1243	Mi-tan	„ 5	16 0 10	98 26 30	16 40	„ 0 34	0·3938	
1244	Kyôndo	„ 6	16 35 50	98 3 50	17 55	„ 0 35	0·3929	
1245	Mya-wadi	„ 7	16 41 20	98 29 50	18 8	„ 0 35	0·3926	
1246	Amherst	„ 8	16 4 50	97 34 0	16 38	„ 0 29	0·3932	
1247	Amin	„ 9	15 39 40	97 44 0	15 41	„ 0 26	0·3936	
1248	Ye	„ 10	15 14 40	97 51 10	14 52	„ 0 31	0·3948	
1249	Mvitta	14/95 2	14 10 50	98 29 50	12 29	„ 0 31	0·3955	
1250	Gônnyin Seik	„ 3	13 41 20	98 18 50	11 21	„ 0 27	0·3953	
1251	Malee	„ 4	13 6 50	98 19 40	10 12	„ 0 31	0·3975	
1252	Kan-hmaw	11/98 3	11 48 20	98 33 20	7 4	„ 0 21	0·3964	
1253	Bôkpyin	„ 4	11 16 40	98 49 30	5 48	„ 0 23	0·3970	
1254	Victoria Point	19/88 1	9 59 30	98 35 20	2 46	„ 0 20	0·3970	
1255	Tena-serim	12/100 1	12 5 40	99 3 30	7 43	„ 0 29	0·3972	Communicated by Mr. D. C. Sowers of the Carnegie Institution of Terrestrial Magnetism.
1256	Srinagar		34 4 17	74 49 1	49 18	„ 2 54	0·3101	
1257	Sonamarg	...	34 18 45	75 18 54	49 30	„ 3 55	0·3107	
1258	Mûlbekh		34 23 2	76 21 29	49 30	„ 3 49	0·3154	
1259	Leh		34 9 30	77 34 15	49 24	„ 3 34	0·3123	
1260	Panamik		34 47 0	77 33 40	50 9	„ 3 53	0·3101	
1261	Kigil Langar	...	35 2 0	78 0 55	50 51	„ 3 59	0·3081	


INDIA
SHOWING STATIONS OF OBSERVATION
of the
MAGNETIC SURVEY.

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season 1908-09—concld.

REOBSERVED FIELD STATIONS.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
20	Asolai	1	26 42 10	72 15 50	37 46	E 0 13	0·3395	H. is derived from Mean M° throughout.
21	Phalodi	5	27 7 40	72 21 50	38 20	,, 2 4	0·3409	
21A	,, (a)	,,	27 7 30	72 21 20	38 15	,, 2 1	0·3415	
71	Lahore	8	31 35 50	74 18 50	45 59	,, 2 58	0·3210	
124	Bíkaner	3	28 0 40	73 18 50	39 58	,, 2 6	0·3389	
139	Viramgám	13	23 8 10	72 3 30	31 19	,, 1 7	0·3565	
157	(Panth) Piplia	1	24 12 20	75 0 40	32 28	,, 1 19	0·3589	
158	Nímbahera	3	24 37 20	74 41 40	34 30	,, 1 38	0·3526	
172	Dhond	3	18 28 0	74 35 10	22 20	,, 0 18	0·3686	
207	Birur	4	13 35 50	75 58 10	11 26	W 0 34	0·3790	
217	Kolhápur	2	16 41 50	74 14 10	18 15	E 0 18	0·3733	
223	Manmád	2	20 14 40	74 26 20	25 29	,, 0 58	0·3654	
260	Kavas	6	25 52 20	71 31 40	35 59	,, 2 7	0·3457	
327	Tuticorin	1	8 48 10	78 9 0	0 7	W 1 20	0·3807	
387	Betragunta	7	14 48 40	79 57 20	14 13	,, 0 57	0·3807	
413	Hardikot, G.T.S.	7	26 57 30	71 51 0	39 10	E 3 6	0·3378	
486	Daltonganj	3	24 2 0	84 4 30	32 54	,, 1 18	0·3605	
544	Bárán	5	25 5 30	76 30 30	35 18	,, 1 27	0·3527	
556	Bárwáha	2	22 15 20	76 1 30	29 40	,, 0 58	0·3631	
590	Anjhi	9	27 38 20	79 59 20	39 26	,, 1 53	0·3469	
593	Kathgodam	1	29 15 20	79 32 50	42 8	,, 2 24	0·3381	
621	Bistán	9	21 41 50	75 40 10	27 54	,, 0 59	0·3758	
622	Khal Ghát	,, 10	22 8 50	75 27 10	33 11	,, 1 54	0·3375	
623	Dhár	,, 11	22 36 0	75 18 30	30 2	,, 0 42	0·3670	
836	Parbatipur	3	25 39 10	88 55 10	36 19	,, 1 22	0·3629	
860	Lumding	6	25 44 50	93 10 40	36 21	,, 1 16	0·3669	

Repeat Stations.

Serial No.	Name of Station.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
		° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
I	Udaipur	24 35 33	73 41 57	34 4	E 1 24	0·3527	H. is derived from Mean M° throughout.
II	Karáchi	24 49 50	67 2 2	34 23	,, 1 42	0·3453	
III	Quetta	30 11 52	67 0 20	43 12	,, 3 1	0·3230	
IV	Bahawalpur	29 23 27	71 40 37	42 14	,, 2 51	0·3316	
V	Ráwalpindi	33 35 16	73 3 6	48 21	,, 3 45	0·3116	
VI	Bharatpur	27 13 27	77 29 28	38 52	,, 1 58	0·3454	
VII	Bangalore	12 59 35	77 35 58	9 57	W 0 41	0·3816	
VIII	Dhárwár	15 27 26	74 59 35	15 31	,, 0 16	0·3758	
IX	Porbandar	21 38 20	69 37 6	28 57	E 1 13	0·3598	
X	Fyzabad	26 47 27	82 7 40	38 1	,, 1 45	0·3535	
XI	Sambalpur	21 28 3	83 58 24	27 58	,, 0 46	0·3733	
XII	Waltair	17 42 57	83 19 1	21 20	,, 0 10	0·3785	
XIII	Darjeeling	26 59 49	88 16 39	38 25	,, 1 32	0·3570	
XIV	Gaya	24 46 30	84 58 54	34 23	,, 1 7	0·3665	
XV	Secunderábád	17 27 11	78 29 16	20 14	,, 0 15	0·3794	
XVI	Bhusával	21 2 46	75 47 18	27 5	,, 0 50	0·3678	
XVII	Jubbulpore	23 8 57	79 56 44	31 11	,, 1 0	0·3641	
XVIII	Tavoy	14 4 50	98 12 30	12 16	,, 0 28	0·3960	
XIX	Lashio	22 56 47	97 44 40	31 18	,, 0 43	0·3766	
XX	Akyab	20 7 53	92 53 58	25 31	,, 0 42	0·3839	
XXI	Silchar or Cáchár	24 49 43	92 47 21	34 44	,, 1 8	0·3694	
XXII	Dibrugarh	27 29 24	94 55 40	39 31	,, 1 15	0·3587	
XXIII	Port Blair	11 39 10	92 43 13	6 18	W 0 8	0·3954	

NOTE.—The above values of Dip, Declination and Horizontal Force are uncorrected for secular change, diurnal variation, instrumental differences, etc., and are to be considered preliminary values only.

Where blanks occur, values have already been found during previous field seasons, or the observations have not been completed.

The Survey numbers refer to the published chart, thus No. 3 denotes No. 3 station, the spherical co-ordinates of whose centre are 26° North Latitude and 76° East Longitude.

All Longitudes are referable to that of Madras Observatory taken at the value 80° 14′ 47″ East from Greenwich.

TOPOGRAPHICAL SURVEYS.

NORTHERN CIRCLE.

NO. 9 PARTY (*vide* INDEX MAP OF NORTHERN CIRCLE FACING PAGE 46).

135. The party continued the work on which it was employed during the preceding season in Dera Gházi Khán district of the Punjab and also extended its operations into the Punjab districts of Miánwáli and Muzaffargarh and also into the Dera Ismail Khán district.

Personnel.

Imperial Officers:

Captain G. A. Beazeley, R.E., in charge from 1st May to 30th September 1909.

Lieutenant E. C. Baker, R.E., in charge from 1st October 1908 to 30th April 1909.

Lieutenant F. J. M. King, R.E.

Provincial Officers:

Messrs. J. A. Freeman, H. C. W. Stotesbury, F. W. Marten, D. K. Rennick, R. C. Hanson, H. W. McDonald and F. J. Grice.

Subordinate Establishment:

26 Surveyors, 6 Draftsmen, 3 Soldier-Surveyors, 2 Computers, 2 Clerks, 1 Store-keeper and 1 Hospital Assistant.

136. This work consisted of 1 inch=1 mile topographical surveys based in the hills on last season's triangulation, and in the plains on traverses executed by No. 1 Party about 30 years ago. Some supplementary traversing and triangulation was needed. In the plains, lines of levels were run to provide heights, but these sheets were not contoured.

137. The field office opened at Leiah on the North Western Railway on the 27th of October 1908 and closed at Dera Ismail Khán on April 8th, 1909. A small section under Lieutenant King, R.E., remained out till the end of the month, to complete some additional work which had been included in the programme at the end of the field season.

138. The resurvey comprised the whole of standard sheets $39\frac{I}{2,3,4,6,7,8,10,11,12,14,15,16}$, $39\frac{J}{1,5,13,14}$ and part of $39\frac{M}{2,3}$. The revision survey comprised the remainder of $39\frac{M}{2,3}$.

139. The character of the ground was varied. Sheets $39\frac{I}{2,3,4,6,7}$, $39\frac{J}{1,5}$ consisted of very broken, hilly, inhospitable country, rising from 800 feet above sea level in the east to 11,000 feet in the west. The remaining area lay on either bank of the Indus, and was flat and sandy, and, except for a strip along the river bank on either side, was extremely dry.

140. The operations were somewhat disturbed in the north-western portion of the work, which fell in Shiráni country. Mr. H. W. McDonald, a young provincial officer, was murdered by fanatics, and surveyor Yakub Ali and two *khalásis* killed, and one *khalási* and one camelman wounded by raiders. This did not, however, prevent the completion of the sanctioned programme.

141. The outturn and cost-rates of the party were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	REMARKS.
		₹	
Triangulation, 1-inch scale	309	11·3	
Traversing	52 (*a*)	34·9	(*a*) Linear miles.
Levelling	115 (*a*)	27·5	
Mapping	...	9·8	
DETAIL SURVEY.			
Re-survey, 1-inch scale	4,313	17·2	
Revision 1-inch ,,	285	14·1	
TOTAL DETAIL SURVEY	4,598		

142. The total cost of the party for the year under report was R1,30,298.

143. During the recess the fair mapping of the following sheets was completed and sent in for publication :—

$39\frac{I}{6, 7, 10, 11, 12, 14, 15}$. The remaining sheets, *i.e.*, $39\frac{I}{4, 8, 16}$, $39\frac{M}{2}$, $39\frac{J}{1, 5, 13, 14}$ are nearing completion. Triangulation charts in degree sheets 34 I. and 34 J. are in progress.

144. The health of the party was only fair, as the district was full of fever, which interfered somewhat with the work.

145. The party offices were inspected by the Surveyor General during July 1909.

NORTHERN CIRCLE.

NO. 12 PARTY (*vide* INDEX MAP OF NORTHERN CIRCLE FACING PAGE 46).

146. The party continued the work on which it was employed last year in the Peshâwar, Hazára and Attock districts.

Personnel.

Imperial Officers :

Brevet-Major E. T. Rich, R.E., in charge up to 20th May 1909.
Lieutenant E. C. Baker, R.E., in charge from 21st May 1909.
Lieutenant S. W. S. Hamilton, R.E., and Captain L. C. Thuillier, I.A.

Provincial Officers :

Messrs. F. H. Grant, H. H. P. Butterfield, F. E. R. Calvert, Rahmatullah, Dhani Ram and Abdul Karim.

Subordinate Establishment :

20 Surveyors (Permanent and Temporary), 3 Soldier-Surveyors, 2 Writers, 1 Computer and 1 Store-keeper.

147. The field office opened at Peshâwar on the 22nd of October 1908 and closed at Râwalpindi on 21st May 1909. One section was left behind to complete the work in the higher hills, and remained in the field until July 29th.

148. The country surveyed in the Peshâwar and Attock districts consisted mostly of rich alluvial cultivated lands broken up by ravines, the average ground level being about 1,000 feet above sea level. In the Hazára district the hills rose to nearly 10,000 feet, and the survey included most of the well-known stations in the Murree hills.

149. The outturn and cost-rates of the party were as follows :—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		R	
Mapping	...	2·4	
DETAIL SURVEY.			
Original survey, 1-inch scale .	953	13·9	
" " 2-inch " .	1,359	42·5	
Forest revision survey, 4-inch scale	70	6·2	
TOTAL DETAIL SURVEY .	2,382		

The 1-inch work comprised the whole of standard sheets $43\frac{F}{3, 4, 7, 8}$, exclusive of the amount of 4-inch Forest revision survey, all of which fell in these sheets. It also included a small portion of work in $38\frac{N}{11}$. The 2-inch work comprised standard sheets $43\frac{C}{5}$, $43\frac{B}{12, 15, 16}$ and parts of $43\frac{B}{7, 8, 11}$, to complete the compilation of these sheets.

150. The total cost of the party for the year under report was R84,012.

151. During recess the following standard sheets surveyed during the year, namely, $43\frac{C}{5}$, $43\frac{B}{7, 8, 11, 12}$ were drawn and sheet $38\frac{N}{11}$ was completed to margin. The following sheets previously surveyed were also drawn and submitted for publication :— $38\frac{N}{8, 12, 16}$, $38\frac{O}{13}$ and $43\frac{B}{4}$. A special ½-inch map was also drawn, and the whole of these maps were forwarded to the Superintendent, Northern Circle, for submission to the Map Publication Office.

152. The health of the party was good.

153. The party was inspected in the field by the Surveyor General during March, and by the Superintendent, Northern Circle, in December, February and March. The recess office was inspected by the Surveyor General in July, and by the Superintendent, Northern Circle, frequently throughout the recess season.

154. The programme for next year consists of the detail and revision survey on the 1-inch scale of 19 standard sheets, namely, 39 $\frac{M}{9, 13, 14}$ and all of sheet 44 A.

NORTHERN CIRCLE.

NO. 14 PARTY (*vide* INDEX MAP OF NORTHERN CIRCLE FACING PAGE 46).

155. The head-quarters of the party remained at Ráwalpindi throughout the field season. The area under survey lay in the Attock, Ráwalpindi, and Jhelum districts of the Punjab, while the triangulation extended into Kashmir. The country under survey was of an open, undulating nature without any high hills; it was, however, intersected by many deep ravines and by broken ground.

Personnel.

Imperial Officers:

Lieutenant O. H. B. Trenchard, R.E., in charge from 1st October 1908 to 15th June 1909. Major C. H. D. Ryder, D.S.O., R.E., attached from 7th to 15th June 1909, and in charge from 16th June 1909. Lieutenant A. A. Chase, R.E., from 1st July 1909.

Provincial Officers:

Messrs. T. W. Babonau, H. H. B. Hanby, H. B. Simons, C. West, A. B. Hunter, W. J. B. Miller, A. G. Wiseman and W. P. Hales.

Subordinate Establishment:

46 Surveyors, etc.

156. Operations in the field commenced at the end of October and the members of the party returned to recess quarters at Mussooree on various dates between the middle of April and middle of May.

157. The party was divided into three camps under Messrs. Babonau, Hanby and Miller, and the following sheets were completed :—

43 $\frac{C}{4}$ (partly surveyed last year) and 43 $\frac{C}{6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}$. Messrs. C. West and A. B. Hunter triangulated for the scale of 1 inch = 1 mile, the remaining portion of 43 G and sheet 43 $\frac{H}{13}$, sheets 43 $\frac{G}{4, 8}$ having already been triangulated and 43 $\frac{G}{12}$ surveyed by the Training Party. Mr. West, assisted by Surveyor Ram Singh, triangulated for the scale of 2 inches = 1 mile, sheets 43 $\frac{C}{12, 16}$ and southern halves of 43 $\frac{C}{11, 15}$. This latter work was computed in the field and used for this season's topography. Mr. F. C. Pilcher was attached to this party for convenience of supervision, but his results have been included in No. 18 Party's report, as he properly belonged to that party.

158. The following table shows in detail the outturn with cost-rates for the year under report, and for purposes of comparison those of the preceding year are also given :—

Description of Survey.	Outturn, sq. miles.		Cost-rate per sq. mile.	
	1907-08.	1908-09.	1907-08.	1908-09.
			₹	₹
Triangulation, 1-inch scale	...	3,760	...	4·2
,, 2-inch ,,	1,365	750	7·2	4·1
Mapping	2,738	3,750	7·7	7·6
DETAIL SURVEY.				
Original survey, 2-inch scale	2,103	2,830	30·5	20·2

159. The total cost of the party for the year under report was R1,10,538.

160. The following 11 sheets (surveyed and drawn on the scale of 2 inches = 1 mile for reduction to the scale of 1 inch = 1 mile), constituting the arrears

of last year, were sent in for publication at the commencement of recess, *i.e.* sheets 38 $\frac{O}{2, 6, 8, 10, 11, 12, 14, 15, 16}$ and 43 $\frac{C}{2, 3}$.

161. All the sheets surveyed during the year under report will be sent in before the close of recess, *viz.*, sheets 43 $\frac{C}{4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}$.

Three sheets surveyed by the Training Party were handed over to No. 14 Party to be drawn. Of these, 43 $\frac{H}{5}$ has been submitted for publication, and the other two, 43 $\frac{G}{12}$ and 43 $\frac{H}{9}$, are complete but await a boundary reference.

162. The health of the party was on the whole fair, but at the commencement of the field season fever was very prevalent. Mr. Wiseman died from injuries received in a railway accident near Dehra Dún while returning to recess. By his death the party has lost a promising young officer.

163. The party was inspected by the Superintendent, Northern Circle, twice during the field season and repeatedly during recess, and by the Surveyor General during recess.

164. The programme for next field season provides for the survey on the scale of 1 inch = 1 mile of sheets 43 $\frac{H}{1, 13}$, and of the whole of 43 G, except 43 $\frac{G}{12}$ already surveyed.

NORTHERN CIRCLE.

No. 18 Party (*vide* Index Map of Northern Circle facing page 46).

165. The head-quarter office of the party opened at Dera Ismail Khán on the 9th November and was transferred to Miánwáli on the 18th February 1909. Field work was, however, commenced during October; a traverse section and an advance party working in Dera Ismail Khán district, the Bári Doáb section at Montgomery and the Riverain section at Lahore.

Personnel.

Imperial Officers:

Captain E. A. Tandy, R.E., in charge till 16th August, and Captain L. C. Thuillier, I.A., in charge from 17th August 1909.

Provincial Officers:

Messrs. J. G. S. Rae, H. W. Biggie, C. E. C. French, J. R. Newland, F. C. Pilcher, H. T. Hughes, Maya Das Puri and Abdul Aziz.

Subordinate Establishment:

26 Surveyors, 19 Traversers, 19 Draftsmen, 19 Computers, 3 Clerks, 1 Store-keeper, 1 Hospital Assistant and 475 Menials.

166. To begin with, surveyors were concentrated on sheets 39 $\frac{I}{5, 9}$, 38 $\frac{P}{1, 2}$ and the trans-Indus portions of 38 $\frac{P}{5, 6, 7}$, in three camps, under Messrs. Biggie, French and Newland, while Mr. Pilcher was employed on triangulation in the Salt Range under the orders of the Officer in charge No. 14 Party.

On the completion of sheets 39 $\frac{I}{5, 9}$ the surveyors were drafted to new ground in sheets 38 $\frac{P}{5, 6, 7, 8, 9}$ and 39 $\frac{M}{1}$.

Under these arrangements all sections were able to finish their work fairly simultaneously; and, before the end of April, Mr. French with a few of the best draftsmen closed work earlier and proceeded to Mussooree to project the fair sheets and put on them the margins, headings, footnotes, etc., and this resulted in a considerable saving of time during recess.

167. The outturn and cost-rates of the party were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		₹	
Triangulation, 2-inch scale .	1,800	3·6	
Traversing	2,642 (*a*)	...	(*a*) Linear miles.
Detail Survey.			
Original survey, 1-inch scale .	1,500	12·4	
„ „ 2-inch „ .	945	33·7	
Total Detail Survey .	2,445		

The rates for the two scales of survey are not fairly comparable, as some of the 2-inch work was very difficult, while the 1-inch work was easy survey in the Thal desert and mostly without contours.

The average monthly outturn per surveyor on the 1-inch scale was 34·2 square miles, and on the 2-inch it was 17·8 square miles.

168. The total cost of the party for the year under report was R1,29,760.

169. The fair mapping of all complete sheets was finished and submitted by the end of the recess.

170. During October and early in November the advance detachments suffered much from fever arising from the recent heavy rains. Later and throughout the actual field season the health of the party was good.

171. The Superintendent, Northern Circle, inspected the party in the field in the Dera Ismail Khán district in December and at Miánwáli in February and March and frequently during recess. The Surveyor General inspected the party in the field in March and during recess in July 1909.

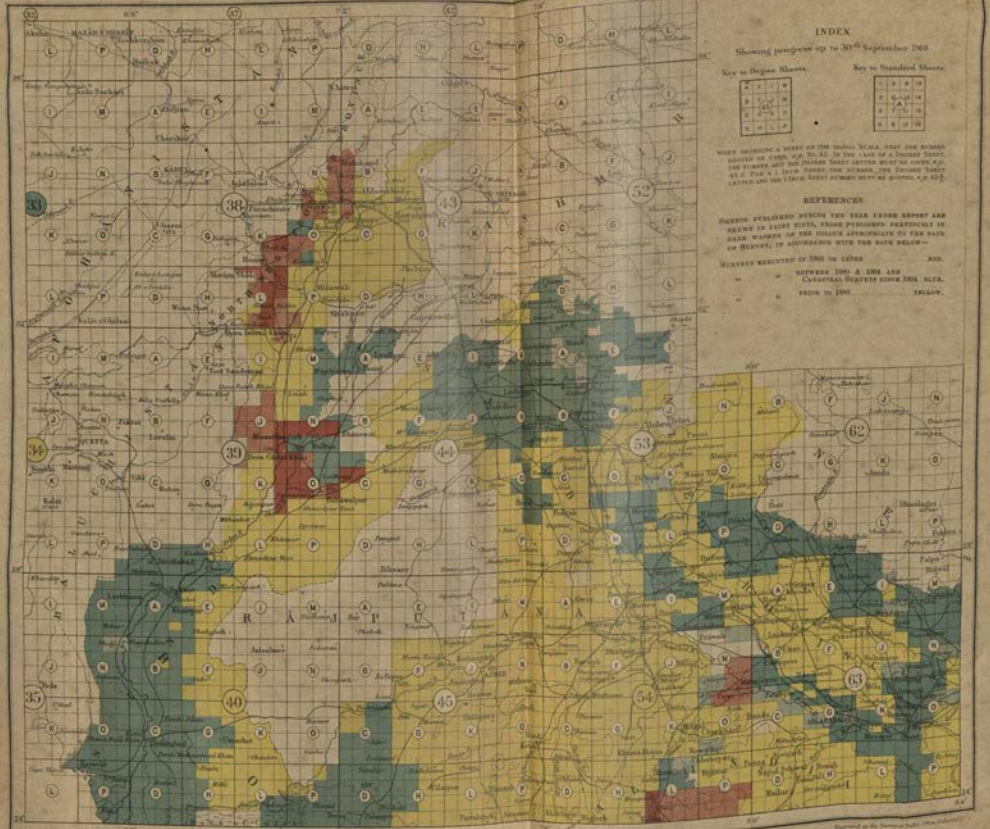
172. The programme for next season consists of the 2-inch survey of sheets 38 $\frac{P}{14, 15}$ and 43 $\frac{D}{1, 2, 5, 6}$ and of the northern halves of 43 $\frac{D}{3, 7}$, covering part of the Salt Range and of the 1-inch survey of sheets 38 $\frac{P}{10, 11, 12, 13, 16}$ and 43 $\frac{D}{4, 8}$ and of the southern halves of 43 $\frac{D}{3, 7}$. Triangulation will be carried out in sheets 43 $\frac{D}{9, 10, 13, 14}$.

173. *Bári Doáb Traverse.*—The traversing and fixing of base lines over the Bári Doáb desert area was finished during the year. Some of the old traverse framework to which all this new work was attached had been unsatisfactorily closed, and caused a good deal of distortion in parts of the new work, and this became in places so very bad that the officer in charge had during the previous recess reviewed the whole situation with a view to distributing the closing errors more satisfactorily over the whole area. This was done, and it was accordingly decided that base-lines must be slightly shifted over a large part of the area to make them correspond to the newly assigned positions, and this work of "alteration" was additional to that mentioned above. A small extension to the west was effected for the Irrigation Department, which they wished to be pushed through rapidly, but the advance party sent for the purpose early in October suffered badly from fever, and the work was greatly impeded during the early part of the season from this cause. Later in the season it was discovered that the corrections had been wrongly applied in the field, and it became necessary to move all the pillars again. Extra men were employed, but even then the work was not completed till the end of May.

174. *Riverain Section.*—This section continued to have its head-quarters at Lahore under Mr. Maya Das Puri. This was a most important year as regards this work, as during it special arrangements were made for utilising the riverain maps and assisting settlement officers in getting all difficulties cleared up on the ground. This work, which was commenced in Gurdáspur district last year, was this season carried out under improved arrangements; a definite scheme was drawn up and accepted by the Settlement Commissioner for still further expediting and cheapening the work of future settlements, and a small selected settlement staff was given a special training for the purpose. Acknowledgments are due to Mr. F. W. Kennaway, the Settlement Officer of Gurdáspur, for the courtesy and patience with which he assisted this section in getting over the preliminary difficulties connected with the first attempt at this work.

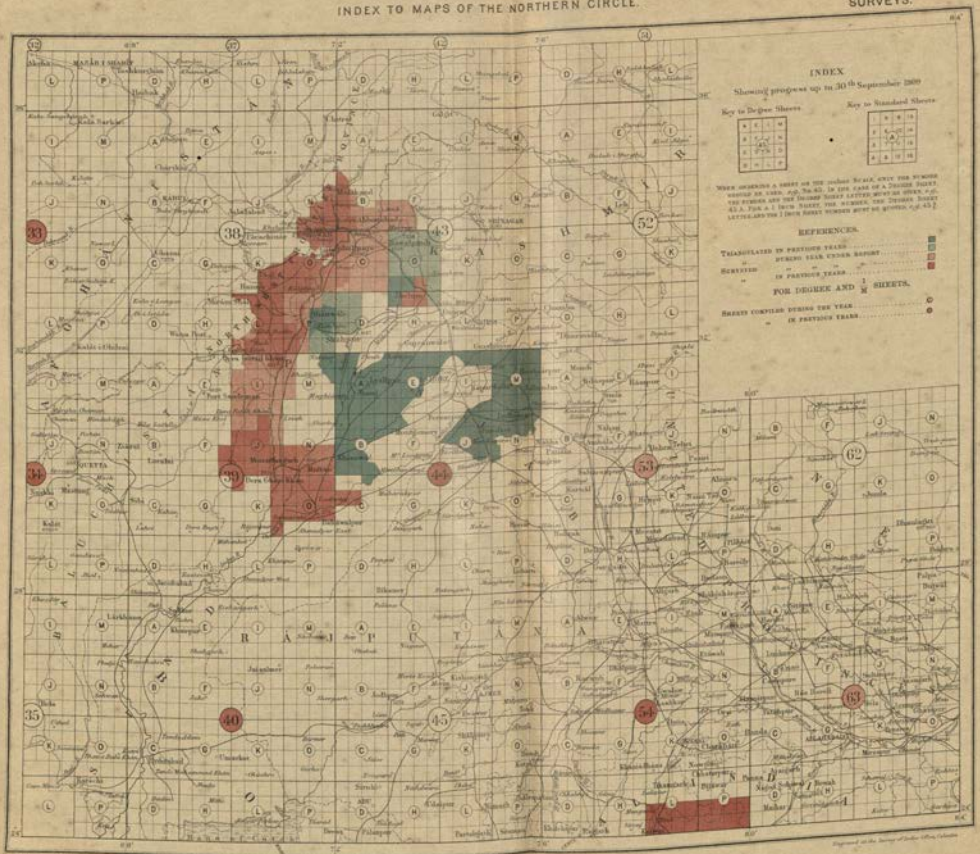
The programme for next season consists of:—(1) Traversing along Sutlej river in Ludhiána district and base-line laying in Jullundur and Hoshiárpur districts. (2) Traversing the Beás river in Amritsar and base-line laying in Kapúrthala State. (3) Traversing the Rávi river in districts Amritsar and Siálkot. (4) Main traverses in the Sutlej, Beás, Rávi, Chenáb and Jhelum rivers.

175. *Punjab Traverse.*—Mr. J. de Graaff Hunter, M.A., was specially attached to the party towards the close of last recess reason to overhaul all the traverse data of the Punjab, to study traverse methods and to advise the riverain and other detachments as to the best way of improving their framework. He was also incidentally looking after a special experimental traverse which No. 24 Party was carrying out with Yáderin wires in the Punjab. For these purposes he established his head-quarters in the office of the riverain section at Lahore and was given a special staff of a few computers.


INDEX
Showing progress up to 30th September 1909
Key to Degree Sheets.
Key to Standard Sheets.
REFERENCES
Surveys published during the year under report are shown in faint tints, those published previously in dark washes of the colour appropriate to the date of Survey, in accordance with the note below.
Surveys executed in 1900 or later ... RED.
... between 1880 & 1904 and Coastal Survey since 1904. BLUE.
... prior to 1880. YELLOW.
RAJPUTANA
GUJARAT
MALWA
BUNDELKHAND
BAGHELKHAND
CHOTA NAGPUR
ORISSA
BERAR
KHANDESH
HYDERABAD
KARNATAK
SHIMOGA
BELGAUM
KOLHAPUR
SATARA
SHOLAPUR
AHMADNAGAR
NASIK
THANA
KOLABA
RATNAGIRI
SAVANTVADI
KANARA
DHARWAR
BIJAPUR
KALADGI
NIZAMABAD
WARANGAL
KHAMMAMETT
NALGONDA
KISTNA
GUNTUR
NELLORE
CUDDAPAH
KURNOOL
ANANTAPUR
BELLARY
RAICHUR
MADRAS
SALEM
COIMBATORE
NILGIRIS
MADURA
TINNEVELLY
TRAVANCORE
COCHIN
PALGHAT
MALABAR
Scale of Miles

INDEX TO MAPS OF THE NORTHERN CIRCLE.

SURVEYS.



He made some very interesting researches into the nature and possibilities of the projection adopted by the department in connection with rectangular co-ordinates, and has devised some labour-saving methods for computations. He further studied the possibilities of traverse work and helped the riverain section to make some most valuable experiments in connection with a system of executing traverse work of a higher degree of accuracy, but involving no prohibitive increase of cost, which we propose to adopt in future for important main traverses. It is hoped that Mr. Hunter may shortly find time to embody the whole of the results of this work in a special paper. He also classified and examined the state of the traverse framework and prepared diagrammatic charts for a large part of the Punjab, but unfortunately his rather sudden transfer to Kashmir at the end of April left this work unfinished. It is hoped that Lieutenant MacLeod may be able to complete it during the coming year.

SOUTHERN CIRCLE.

CENTRAL PROVINCES AND CENTRAL INDIA AGENCY.

No. 1 Party (*vide* Index Map of Southern Circle facing page 54).

176. The sphere of this party's operations lay in the Jubbulpore, Mandla, Saugor, Damoh and Narsinghpur districts of the Central Provinces, and in the Rewah State of the Central India Agency. The work was in continuation of, and of the same nature as, that carried on in the previous year, with the exception that a certain amount of the revision survey was undertaken on the 1-inch scale.

Personnel.

Imperial Officers:

Lieutenant K. W. Pye, R.E., in charge up to 12th June 1909.
Lieutenant M. N. MacLeod, R.E., in charge from 13th June to 27th September 1909.
Major C. L. Robertson, C.M.G., R.E., in charge from 28th September 1909.

Provincial Officers:

Messrs. F. S. Bell, F. P. Walsh, W. Skilling, C. Litchfield, B. M. Berrill, R. E. Saubolle, J. G. D. Vander-Beek and Munshi Lal.

Subordinate Establishment:

38 Surveyors, etc.

177. Field work was commenced on the 1st November 1908, and closed on the 20th April 1909, when the programme was completed, with the exception of a portion of sheet $64\frac{A}{14}$. The recess office opened at Poona on the 25th April 1909.

178. The country surveyed was of a varied nature. In the eastern portion of the work it was undulating and open, while in the south and west, particularly in the Rewah State, hilly country prevailed, much broken up by ravines and covered with jungle. About one-third of the area surveyed was so densely wooded as to preclude survey by plane-table fixings, and much hindered the triangulation.

The area surveyed lay in sheets $55\ \frac{M}{1, 2, 3, 5, 9\ (part)}$, $55\ \frac{N}{5}$, $64\ \frac{A}{1, 5, 9, 10, 13, 14\ (part)}$ and also a portion of $55\ \frac{I}{10}$. Some 240 miles of topographical traversing was done in the jungles where it was found impossible to triangulate.

179. The outturn and cost-rates of the party were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		₹	
Triangulation	3,099	7·7	
Fair mapping	3,272	6·1	
Detail Survey.			
Original survey, 1-inch scale	436	26·3	
„ „ 2-inch „	41	6·6	
Revision „ 1-inch „	951	13·0	
„ „ 2-inch „	1,716	12·0	
Total Detail Survey	3,144		

The average monthly outturn per surveyor for each class of work was as follows:—

Original survey, 1 inch = 1 mile —14·4 square miles with 16 fixings and 4 heights per square mile.

Original survey, 2 inches = 1 mile —16 square miles with 10 fixings and 5 heights per square mile.

Revision survey, 2 inches = 1 mile —18·6 square miles with 10 fixings and 5 heights per square mile.

Revision survey, 1 inch = 1 mile —19·9 square miles with 11 fixings and 6 heights per square mile.

Triangulation—150 square miles.

Topographical traversing—31·5 linear miles with 4 stations per mile.

Three officers were employed throughout the year for instructional purposes on the 1-inch original survey work, which partly accounts for the high rate.

180. The total cost of the party for the year under report was ₹91,793.

181. With the exception of slight difficulties entirely due to a misunderstanding experienced at the beginning of the season in the Rewah State, there has been no reason again to complain of the attitude of the local authorities, and everywhere the necessary help and assistance was afforded and relations were friendly.

182. The fair mapping of the following sheets has been undertaken during the recess. On the scale of 2 inches = 1 mile—sheets 55 $\frac{M}{1, 5, 9}$, and 55 $\frac{N}{5}$. On the scale of $1\frac{1}{2}$ inches = 1 mile—sheets 55 $\frac{I}{10}$, 55 $\frac{M}{2, 3}$ and 64 $\frac{A}{1, 5, 9, 10, 13}$. It is hoped that all these will be completed and submitted for publication at the end of the recess. In addition, sheets 54 $\frac{P}{4, 7, 8, 12, 16}$, and 55 $\frac{M}{13}$, mostly mapped in the previous recess, were completed and submitted for publication.

183. The triangulation computations have not been entirely worked out; but more than sufficient points for the plane-tables required at the beginning of the season are available, and the remainder will be computed during the field season. Pending the completion of the triangulation no charts have been undertaken.

184. There was a good deal of sickness at the beginning of the field season, chiefly from malaria.

185. The party was inspected in recess during August 1909 by the Surveyor General, and in the field during January and in recess during August by the Superintendent, Southern Circle.

186. The programme of work for next field season consists of triangulation of sheets 55 $\frac{I}{2, 3, 4, 7, 8}$ and 55 $\frac{J}{1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 14, 15}$, about 4,120 square miles in all. The topographical survey will consist of original survey on the 1-inch scale in the Rewah portion, with recontouring of the Jubbulpore portions, falling in sheets 64 $\frac{A}{4, 8, 11, 12, 15, 16}$, while 64 $\frac{A}{14}$ will be completed. Sheets 55 $\frac{I}{14, 15, 16}$ and 55 $\frac{M}{4, 6, 7, 8}$ will be recontoured on the scale of $1\frac{1}{2}$ inches = 1 mile. The old work has been found in previous seasons to be so accurate that practically no revision is required, and this work in future will generally be confined to recontouring. In addition to the above, if time permits, supplementary work will be done in sheets 55 $\frac{I}{9, 13}$, 55 $\frac{M}{10, 11, 12, 14, 15, 16}$, 55 $\frac{N}{9, 13}$ and 64 $\frac{A}{2, 3, 6, 7}$, which have been published in the old style and on the old graticule from comparatively recent surveys with a view to their being redrawn and published in the new style as early as possible.

CENTRAL PROVINCES AND BERÁR.

No. 2 Party (*vide* Index Map of Southern Circle facing page 54).

187. The party has been employed, during the year under report, in continuing the survey of Berár on the 1-inch and 2-inch scales as an ordinary topographical party, instead of being a training party as in previous years. Divided into four topographical camps, the party took the field at Badnera on the 26th October, the head-quarters being subsequently moved to Amraoti, when the camps had moved to their respective districts. The native *personnel* was rather a mixed one, being made up of men transferred from other parties, and of new hands. The large majority of the surveyors were practically untrained, more than half of the men being in their first field season. Fortunately, however, the greater part of the area undertaken was easy to survey, and not only was the programme accomplished, but two additional standard sheets had been completed when the party returned to recess quarters, which opened at Poona on the 3rd May. The advance triangulation was however much delayed both by the lack of officers with experience of triangulation, and by accidents or illness which befell those who were successively entrusted with this important work, and it was not until the beginning of June that a sufficient area for a portion of next season's detail work was completed. This will be supplemented by sending an officer to triangulate the remaining area a month before the surveyors take the field. In addition to the ordinary programme, a network of tertiary triangulation was extended from sides of the Great Arc series over the whole of sheet 55 L, as the work of the previous year had disclosed accumulated errors of too great magnitude to allow of extension without careful checking.

Personnel.

Imperial Officers:

Captain H. Wood, R.E., in charge, Lieutenant J. A. Field, R.E.

Provincial Officers:

Messrs. A. Ewing, C. G. Lee, Amar Singh, P. Kennegy, E. A. Meyer, F. C. Saint, R. B. Gildea and C. B. Sexton.

Subordinate Establishment:

27 Surveyors, 3 Pupils and 4 Soldier-Surveyors, 4 Clerks, etc.

188. The country surveyed presented much variety. That lying in sheet 55 H. consisted of the broken ground leading down from the Basim plateau to the low undulating plains through which the Púrna river flows. This country with its black cotton soil is very fertile and highly cultivated, and presented no difficulties for the surveyor other than arose from the height and density of the *jowári* crops which form the staple food supply of the people. The approaches to the plateau, on the other hand, were stony and rocky, intricate to survey, and overrun with a poor forest growth. The ground surveyed in sheet 55 L was the eastern end of the Yeotmál plateau sloping down to the Wardha river plains below, but the slope was more gradual and less cut up than on the other scene of operations. There was, however, much more dense forest on the plateau and slopes which presented difficulties to the surveyors, but the work in the plains was most easy.

189. The area surveyed lay in sheets 55 $\frac{H}{1, 2, 3 \text{ (part)}, 5, 6}$, and 55 $\frac{L}{2, 3, 4, 6, 7}$.

190. The outturn and cost-rates of the party were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		₹	
Triangulation	2,229	11·4	
Skeleton forest boundary survey, 4-inch scale.	461	5·8	
Fair mapping	2,688	8·4	
Detail Survey.			
Original survey, 1-inch scale	2,448	15·2	
„ „ 2-inch „	240	55·0	
Total Detail Survey	2,688		

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The average monthly outturn of detail survey per surveyor was as follows:—

Original survey 1 inch =1 mile —20·8 square miles with 16 fixings and 3 heights per square mile.

Original survey 2 inches =1 mile —7 square miles with 49 fixings and 13 heights per square mile.

Triangulation was carried on under such exceptional circumstances that no reliable average outturn can be given.

191. The total cost of the party for the year under report was R1,02,703.

192. With the exception of an unprovoked assault by the people of Kalamb on Mr. Ewing, for which the assailants were tried, convicted and sentenced by the civil authorities, the relations with the villagers were friendly, and the district officials afforded every assistance.

193. The fair mapping of all the sheets surveyed was practically finished during the recess, and sheets 55 $\frac{H}{1, 2, 3, 5, 6}$ and 55 $\frac{L}{2, 3, 4, 6}$ will very shortly be submitted, while 55 $\frac{L}{7}$ will be forwarded later on during the field season. A triangulation chart of sheet 55 H has also been nearly completed, but the insertion of the extra detail on the 2-inch Forest editions of the 1-inch sheets published last year could not be undertaken for lack of competent draftsmen.

194. The health of the party was on the whole good. One *khalási* died of cholera, and one was killed by a bear, while Mr. Saint and a surveyor, both of whom were engaged on triangulation, had to be sent on sick leave during the field season.

195. The Surveyor General inspected the party at Poona during the recess accompanied by the Superintendent, Southern Circle, who also inspected the party during the field season.

196. The programme for next year comprises the detail survey of sheets 55 $\frac{L}{8, 9, 10, 11, 12, 13, 14, 15, 16}$, 55 $\frac{P}{4}$, 56 $\frac{I}{13}$ and 56 $\frac{M}{1}$, while sheets 55 $\frac{P}{4}$, 56 $\frac{E}{1, 2, 5, 6, 9, 10, 11, 13, 14, 15}$, and 56 $\frac{I}{1, 2, 3, 5, 9, 13}$, and 56 $\frac{M}{1}$ are to be triangulated.

BOMBAY PRESIDENCY, CENTRAL INDIA AGENCY, AND HYDERÁBÁD.

NO. 17 PARTY (*vide* INDEX MAP OF SOUTHERN CIRCLE FACING PAGE 54).

Personnel.

Imperial Officers:

Lieutenant S. W. S. Hamilton, R.E., in charge from 26th October 1908 to 30th September 1909.

Lieutenant A. H. Gwyn, I.A., from 10th November 1908.

Provincial Officers:

Mr. S. F. Norman (Senior), in charge, from 1st to 25th October 1908.

Messrs. J. H. S. Wilson, P. R. Anderson, J. R. Newland, A. K. Mitra, F. B. Kitchen, B. F. Cooper, C. O. Picard, P. C. Mitra, E. J. Hanby and A. J. Booth.

Subordinate Establishment:

34 Surveyors, 3 Clerks, etc.

197. The work carried on by this party was of the same nature, and in continuation of that of the previous season. The northern portion of the area surveyed lay in the Indore and Barwáni States of the Central India Agency while in the south, the east and west Khándesh districts of the Bombay Presidency formed the scene of operations. Triangulation was carried on mainly in the Aurangabad district of the Hyderábád State.

198. Mr. S. F. Norman did not take the field, and on the completion of some examination work proceeded on combined leave from 17th December 1908, preparatory to retirement on 8th August 1909, after 35 years' service, the last twenty of which were passed in this party. Mr. Cooper tendered his resignation, which was accepted, from 1st May 1909.

199. The party, divided up into 5 camps, took the field on the 12th November 1908 at Nardhana, whence the head-quarters were on the 21st November moved to Fort Sendhwa, Indore. The field season lasted until the end of April, when the programme was completed, with the exception of sheet 46 $\frac{O}{15}$, which it was found could not be finished in reasonable time. The recess office opened at Poona on 5th May 1909.

200. The season's operations comprised :—

(1) Revision survey on scale 1 inch=1 mile of sheets 46 $\frac{K}{9, 13}$ and 46 $\frac{O}{1, 5, 6, 9, 10, 13, 14}$ and parts of 46 $\frac{O}{2, 7, 11}$, amounting to 2,985 square miles.

(2) Resurvey on scale 2 inches=1 mile of 603 square miles of reserved forest area previously surveyed on the 1-inch scale falling in sheets 43 $\frac{O}{3}$ and sheets 46 $\frac{O}{2, 7, 11}$.

(3) Boundary skeleton surveys on the scale 4 inches=1 mile of all reserved forest areas falling in sheets 46 $\frac{O}{2, 3, 7, 11}$ pertaining to the Shirpur, Chopda and Yával ranges of the Sátpurás, amounting to 205 linear miles.

(4) Triangulation of about 2,100 square miles falling in sheets 46 $\frac{P}{6, 10, 14 \text{ (part)}}$ and 46 $\frac{P}{3, 4, 7, 8, 11, 12, 15, 16}$.

201. The scene of the detail survey operations was situated midway between the Narbada and Tapti rivers. The watershed of these rivers is the Sátpurá range, which rises to an elevation of two and three thousand feet above mean sea-level, and forms the southern boundary of the Indore State.

In the south these Sátpurás break off into high ranges, the one running along the south of Indore State, the other bounding the plains of the Tapti valley. The whole of this portion of the East and West Khándesh districts is mountainous and rugged, and covered with trees and long grass. Villages are few and far between, water is scarce, transport difficult to obtain, and, with the exception of the Bombay-Agra road which passes on the west edge of the work, and of a main road which runs through the centre along the Aner river, communications are extremely bad.

These remarks apply equally to the southern portion of the Indore State, where the Bombay-Agra road, running north and south, is the only efficient means of communication, while the country in the Barwáni State is even more difficult.

In the northern portion of the work in Indore State near the valley of the Narbada river, the country is well populated and fertile, communications are good and water plentiful.

202. Local labour was largely employed both on account of the scarcity of experienced *khalásis* and owing to its inherent advantages. But it is not safe to count on more than one-third of the menial staff being thus obtained. While such men are invaluable as guides and for obtaining supplies, they will not turn out to work early, and will rarely proceed beyond their village limits.

203. The outturn and cost-rates of the party were as follows :—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
Triangulation . . 1-inch scale	2,100	5·2	
Skeleton boundary survey, 4-inch „	205 (*a*)	5·2	(*a*) Linear miles.
Fair mapping . . 1½-inch „	3,588	5·2	
DETAIL SURVEY.			
Revision survey . . 1-inch scale	2,985	13·9	
Re-survey . . . 2-inch „	603	19·1	
TOTAL DETAIL SURVEY .	3,588		

The detail surveys were tested throughout by *in situ* fixings, as the nature of the country, except in a very few cases, did not admit of chain *partal*. The monthly averages per surveyor for revision and re-survey were as follows :—

Revision on scale of 1-inch=1 mile, 23·5 square miles with 10 fixings and 4 heights per square mile.

Re-survey on scale of 2 inches=1 mile, 11·7 square miles with 27 fixings and 6 heights per square mile.

204. The total cost of the party for the year under report was R93,509, which includes an expenditure of R10,363 on publication charges and the completion of the 4-inch Forest Maps surveyed in 1905-06.

205. The area under re-survey on scale of 2 inches=1 mile embraced 394 square miles of reserved forest, and was distributed as under:—

Taluka.	District.	Area in square miles.
Shirpur	West Khándesh	133
Chopda	East "	163
Yával	" "	98
	TOTAL	394

While the skeleton forest boundary survey, amounting to 205 linear miles, was apportioned as below:—

Taluka.	District.	Linear miles.
Shirpur	West Khándesh	96
Chopda	East "	77
Yával	" "	32
	TOTAL	205

206. The fair mapping made good progress during the year. In October 1908 there were 45 Forest survey sheets in arrears and 5 sheets of current topographical work on a scale of 2 inches=1 mile to be completed and examined. For dealing with these, a small drawing establishment was left in recess when the party took the field. Of the forest sheets, 23 were practically finished, and were examined and despatched for publication early in the year under report. The fair drawing and examination of the five sheets remaining incomplete at the end of last year (sheets $46\frac{K}{1,2,5,6,14}$) were completed by the end of January, when they also were sent in for publication. The remaining 22 sheets of forest survey arrears have now been completed, and will be submitted before the party takes the field. The drawing of the 13 standard sheets of the current season's survey is well in hand, and sheets $46\frac{O}{1,2,5,6,9,10,13,14}$ and $46\frac{K}{13}$ should be completed about the end of October 1909, while the remaining 4 sheets $46\frac{O}{3,7,11}$ and $46\frac{K}{9}$ should be ready about a month later.

207. The drawing of additional detail on the 2-inch sheets for the Forest Department has not yet been taken in hand.

208. All computations have been completed up to date. The triangulation charts of sheets 46 K and O are not quite ready for submission.

209. Mr. Sheffield, of the Federated Malay States survey, was attached to the party for training in practical field work at the commencement of the season, and was employed on plane-table surveying for about 2 months, when he was transferred to the Burma Circle to complete his course.

210. On the whole the health of the party was excellent throughout the year. Three *khalásis* died.

211. The party was inspected by the Surveyor General at Poona during July 1909, and by the Superintendent, Southern Circle, during the same month, as well as at the end of January.

212. The programme for next season comprises:—

(*a*) Detail survey on scale 1 inch=1 mile in sheets $46\frac{P}{4,7,8,11,12,15,16}$ and parts of sheets $46\frac{P}{3,6,10,14}$, amounting to 2,550 square miles.

(*b*) Revision survey on the scale 1 inch=1 mile in sheets $46\frac{P}{1,2,5,9,13}$ and parts of sheets $46\frac{P}{3,6,10,14}$ and $46\frac{O}{15}$, amounting to 1,750 square miles.

(*c*) Re-survey on the scale 2 inches=1 mile of reserved forest areas in sheets $46\frac{O}{15}$ and $46\frac{P}{9,10,13,14}$, amounting to about 390 square miles.

(*d*) Boundary traverse of such forests in sheets 46 $\frac{O}{15}$ and 46 $\frac{P}{9, 10, 13, 14}$ as are surveyed under (*c*) above.

(*e*) Triangulation in sheets 55 $\frac{D}{1, 4, 5, 8, 9, 12, 13, 14, 16}$ and 56 $\frac{A}{1, 5, 9, 13}$ and to complete triangulation in sheets 55 $\frac{D}{2, 3, 6, 7, 10, 11, 15}$, amounting in all to about 5,600 square miles.

MADRAS.

NO. 19 PARTY (*vide* INDEX MAP OF SOUTHERN CIRCLE FACING PAGE 54).

213. The party left its recess quarters at Bangalore in November 1908 and returned there in June 1909, giving a full field season of six-and-a-half months.

Personnel.

Imperial Officers :

Major C. W. H. Symonds, I.A., in charge from 16th October 1908 to 27th June 1909.

Lieutenant C. G. Lewis, R.E., in charge from 1st to 16th October 1908 and from 28th June to 30th September 1909.

Provincial Officers :

Messrs. J. Smith, W. F. E. Adams, E. J. Biggie, W. H. Strong, A. J. Fraser, J. St. C. Pollet, Mahadeva Mudaliar, Balaji Dhondiba and M. S. Ganesa Aiyar.

Subordinate Establishment :

26 Surveyors, 3 Traversers, 2 Writers and 1 Hospital Assistant.

214. The outturn and cost-rates of the party are given in the following table :—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		ℝ	
Triangulation	5,850	3·1	
Traversing	30(*a*)	40·3	(*a*) Linear miles.
DETAIL SURVEY.			
Original survey, 1-inch scale	713	25·1	Including mapping.
,, ,, 2-inch ,,	1,065	62·4	
Revision, ,, 1-inch ,,	770	15·0	
TOTAL DETAIL SURVEY	2,548		

Owing to four Sub-Assistant Superintendents on probation having been attached to the party for instruction, and to the heavy cost of transport and labour in the Nilgiris, the cost-rates are high. The average monthly outturn per surveyor on the 1-inch scale was 28·92 square miles, on the 2-inch it was 8·51 square miles, and on the 1-inch revision was 44·60 square miles.

215. The total cost of the party for the year under report was ℝ1,16,386.

216. The programme of the party for the year under report consisted of the survey of standard sheets 49 $\frac{N}{13, 14}$, 58 $\frac{A}{8, 9, 10, 11, 12, 13, 14, 15, 16}$, 58 $\frac{B}{9, 13}$, and the completion of sheet 58 $\frac{A}{7}$. It was found early in the season that this programme could not be completed and it was decided to abandon the survey of sheets 58 $\frac{B}{9, 13}$, and, owing to the early break of the monsoon, sheets 58 $\frac{A}{11, 12, 15, 16}$ were unfinished. The thickly populated coastal tract, also the Nilgiris district, more than half the area of which consists of forest reserves, and the forests of the Malabar district were surveyed on the 2-inch scale, while the remaining area was surveyed on the 1-inch scale.

217. As was anticipated, the old Mysore maps proved extremely accurate, and, generally speaking, the only corrections required were the actual changes in village sites, limits of cultivation, etc. In Coimbatore district the 4-inch forest survey was utilized for supplementary survey on the 1-inch scale.

218. Of the country topographically surveyed, the coastal tract comprised in sheets 49 $\frac{N}{13, 14}$ presents the same features as were encountered in previous seasons, *i.e.*, a densely populated area extending up to the foot of the *ghats*, in

which each habitation was separately surveyed and mapped. The average number of huts over the whole of this area is 150 to the square mile, while along a narrow belt parallel to the coast there are as many as 400 to the square mile. The Nílgiri plateau, consisting mainly of open downs, is an ideal country for the plane-tabler, though the work was rendered tedious by the large number of forest reserves (some 450) and by the extraordinary intricacy of their boundaries; but it was on the *ghat* slopes that the surveyors met with the greatest difficulty; here, except in the vicinity of coffee estates, there were no roads, the jungle was extremely dense, and the climate trying, especially at the foot of the hills. In April, the early rains commenced, and the greater part of May was lost owing to the unusual amount of rain and to mists which, rising daily from the plains, by 10 A.M. completely enveloped the upper hills. It is due mainly to these causes and to sickness among the surveyors that 5 sheets remained incompletely surveyed.

219. The following maps will be submitted for publication before the end of the year:—

Sheets $49\frac{M}{14}$, $49\frac{N}{13, 14}$, drawn on the 2-inch scale, and sheets $58\frac{A}{8, 9, 10, 13}$, drawn on the $1\frac{1}{2}$-inch scale.

220. The triangulation of sheets 58 B and 58 C was completed, and that of 58 D and 58 H in Cochin and Travancore States was commenced; the computations have been completed during recess. Triangulation charts 49 M, 49 N and 58 A will be submitted for publication.

221. The boundaries of forest reserves in South Malabar were traversed by theodolite, but in The Nílgiris this was not deemed necessary.

222. In the plains the health of the party was good, but in the Wynaad and in the malarious Attapádi and Silent valleys the surveyors suffered from very severe attacks of fever, and even those who worked in The Nílgiris did not escape. One surveyor and three *khalásis* died during the year.

223. The party was inspected during recess by the Surveyor General and by the Superintendent in charge, Burma Surveys.

224. The programme for next season consists of the survey of sheets $58\frac{B}{1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 14, 15}$, and the completion of sheets $58\frac{A}{11, 12, 15, 16}$, mostly on the 1-inch scale, in the Malabar and Coimbatore districts and in the Cochin and Travancore States. The densely populated areas on the coast and a few forest reserves in South Malabar will be surveyed on the 2-inch scale. The triangulation of the south of the peninsula, west of latitude 77° 30′, will be completed.

MADRAS.

COORG DETACHMENT (*vide* INDEX MAP OF SOUTHERN CIRCLE FACING PAGE 54).

225. The detachment was formed at Bangalore on the 1st November 1908 for the purpose of commencing survey operations in Coorg. It proceeded to the field on the 8th November 1908 and returned to Bangalore in the end of June 1909.

Personnel.

Provincial Officers:

Mr. R. Waller-Senior, in charge and Mr. E. Claudius.

Subordinate Establishment:

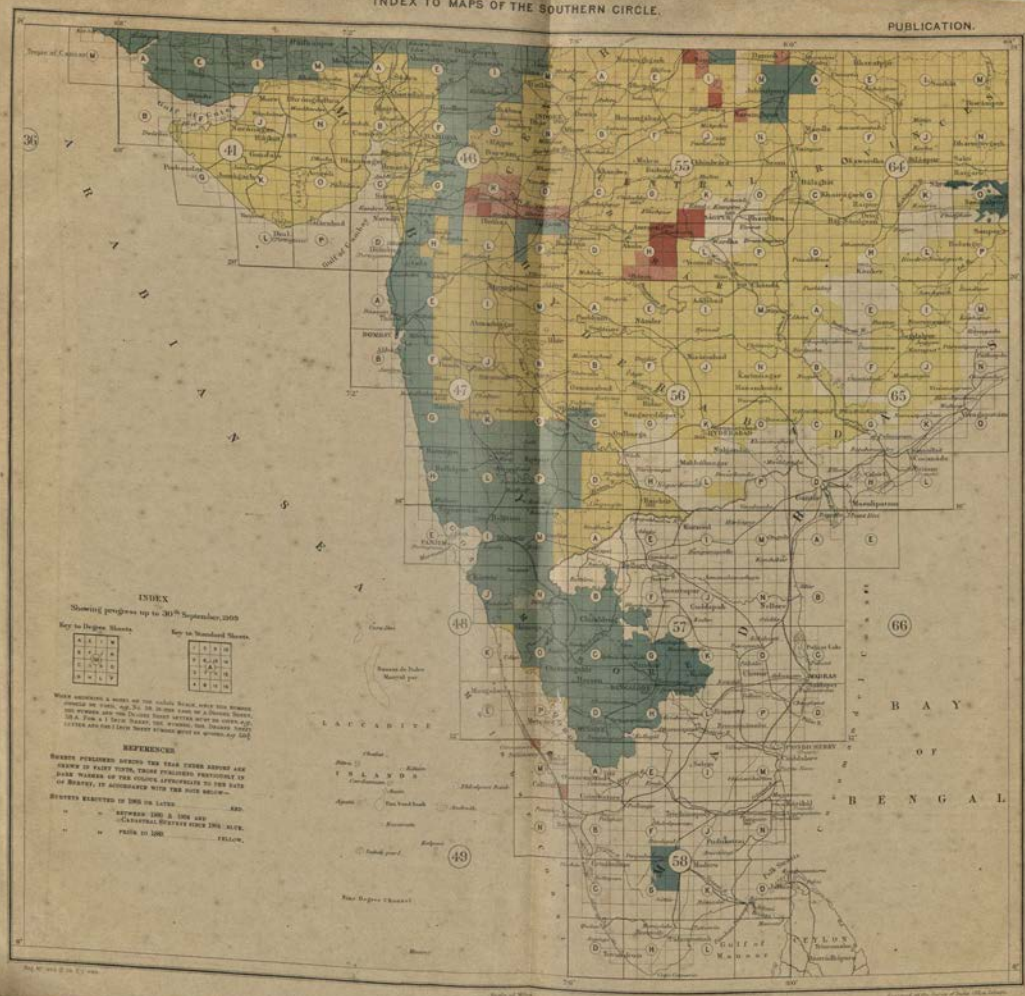
11 Surveyors and 1 Writer.

226. The outturn and cost-rates were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		₹	
Triangulation	2,565	6·9	
DETAIL SURVEY.			
Original survey, 2-inch scale . .	558	36·9	

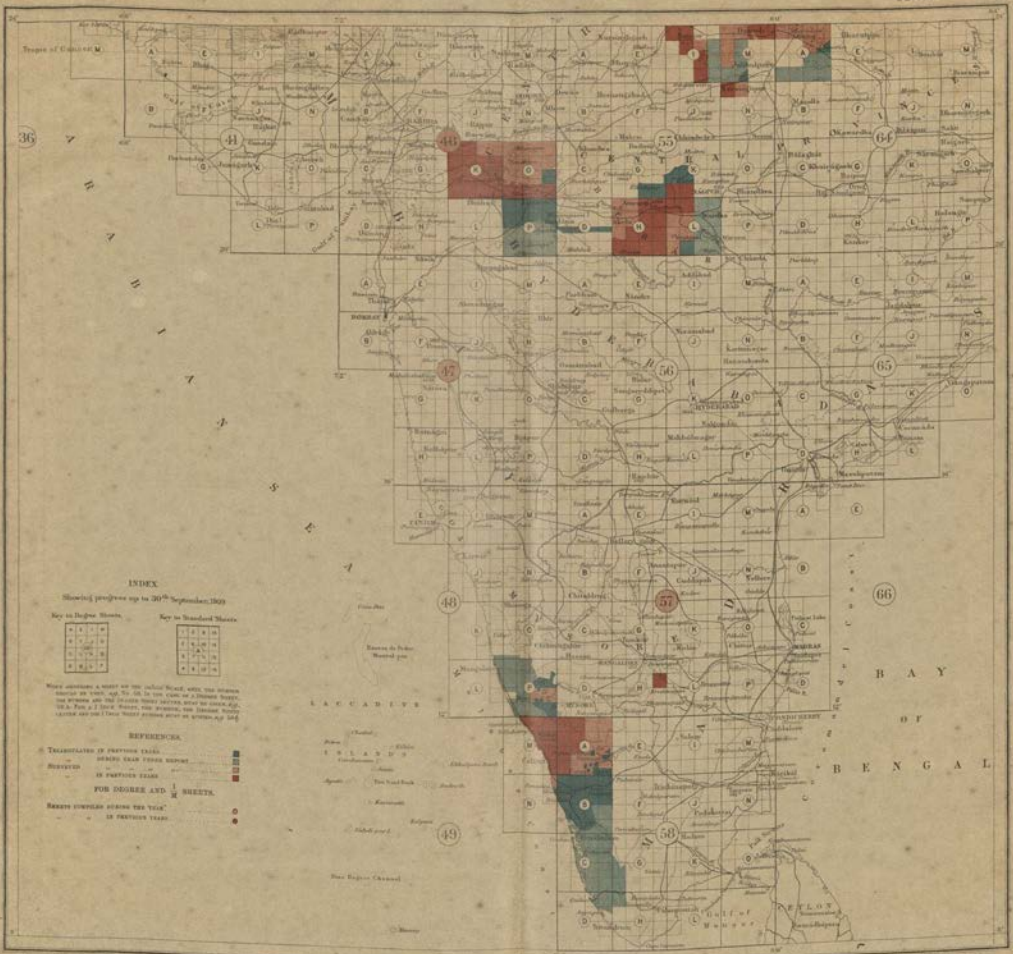
INDEX TO MAPS OF THE SOUTHERN CIRCLE.

PUBLICATION.



INDEX TO MAPS OF THE SOUTHERN CIRCLE.

SURVEYS.



The average monthly outturn per surveyor was 7·6 square miles.

227. The total cost of the detachment for the year under report was R36,681.

228. The programme of the detachment consisted of advance triangulation for No. 3 Party in the Malabar and South Canara districts and in Coorg and of the detail survey of sheets $48\frac{P}{11,\ 15}$. In spite of the triangulators remaining out in the field until well on in the rains, the triangulation could not be completed. The detail survey was completed, with the exception of 22 square miles, which will be surveyed by No. 3 Party early next season.

229. The area topographically surveyed lay chiefly in Coorg but also comprised small portions of Mysore State and of the South Canara district. The country is thickly wooded and consequently the progress of the work was slow; the early break of the monsoon was another adverse feature of this field season.

230. Sheet $48\frac{P}{15}$ was drawn on the $1\frac{1}{2}$-inch scale for reduction to the 1-inch scale; it will be completed in the Circle drawing office and will be submitted for publication before the end of the year. The triangulation was connected with the Madras Longitudinal and the Mangalore Meridional series.

231. Mr. Sheffield, an officer of the Survey Department of the Federated Malay States, was attached to the department for a few weeks in April 1909 for instruction.

232. The health of the party throughout the year was good.

233. The detachment was inspected in the field by the Deputy Surveyor General and in recess by the Surveyor General and by the Superintendent in charge, Burma Surveys.

234. The detachment will be disbanded on the 31st October 1909, and will be absorbed in No. 3 Party, which will continue work in the Madras Presidency to the north of latitude 12°.

EASTERN CIRCLE (BURMA).

BURMA.

NO. 3 PARTY (*vide* INDEX MAP OF EASTERN CIRCLE FACING PAGE 62).

235. The recess office closed in Bangalore on the 2nd November 1908 and re-opened there again on the 1st June 1909, giving an average of six months' actual work in the field for the whole party.

Personnel.

Imperial Officer:

Captain C. P. Gunter, R.E., in charge.

Provincial Officers:

Messrs. W. M. Gorman, J. O'B. Donaghey, W. E. S. Swiney and H. D. W. Stotesbury.

Subordinate Establishment:

23 Surveyors, 1 Draftsman, 2 Writers and 1 Hospital Assistant.

236. The outturn and cost-rates of the party for the year under report were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
DETAIL SURVEY.		₹	
Original survey, 1-inch scale . .	1,095	39·5 (*a*)	(*a*) Including mapping.
„ „ 2-inch „ . .	39 (*b*)	96·2 (*a*)	(*b*) Forest reserves.
Supplementary survey, 1-inch scale .	1,486	27·0 (*a*)	
Revision survey (Forests), 1-inch scale .	411	20·0 (*a*)	
TOTAL DETAIL SURVEY .	3,031		

The average monthly outturn per surveyor for supplementary survey on the 1-inch scale was 28 square miles, on the 1-inch survey it was 20 square miles, on the 2-inch survey 8 square miles, and on the 1-inch revision survey 41 square miles.

237. The total cost of the party for the year under report was R96,892.

238. The country proved very difficult to survey. Almost the whole area had to be rigidly traversed, and this accounts for the poor outturn. As there was no triangulation done by the party this season, the whole of the charges for supervision have been debited to survey: this accounts for the unusually high cost-rates. If the share of supervision, which is usually borne by the triangulation, be deducted from the cost of survey, the cost-rates work out to much the same as those of last year.

239. The programme, which was completed, consisted of the survey of sheets 84 $\frac{J}{9, 10, 11, 12, 13, 14, 15, 16}$ and 84 $\frac{K}{9, 13, 14}$ comprising parts of the Upper and Lower Chindwin, the Pakôkku and the Shwebo districts.

240. The area under survey was again of a very varied character. In the north, the Chindwin river forces its way in a very tortuous manner through rugged forest-clad country, much cut up by streams and very difficult to survey. The country rises gradually in the west to the hills of the Mahudaung range, about 2,000 feet above sea-level. In the south is a highly cultivated plain, interspersed with small scattered areas of undulating hills covered with open jungle; the cultivation consists mostly of "*Juar*," which grew very high this year, and for two months greatly impeded the progress of the work. Three of the interesting extinct volcanoes known locally as "*Twins*" on the west of the Chindwin river in the Lower Chindwin districts occur in this area. There is a lake of sulphurous water in each crater, and the water level, when measured in April, was found to be some 170 feet below the height of the surrounding country and about 30 feet above the level of the nearest water in the Chindwin river.

241. The whole area surveyed was mapped on the 1½-inch scale for photographic reduction to the 1-inch scale and will be shortly submitted for publication. The mapping of the party again shows an improvement both in quantity and quality.

242. Surveyor Pertab Singh was deputed to accompany Colonel Lumsden, C.B., on an expedition into the Mishmi country, north of Assam; he completed the survey of 250 square miles of hitherto unmapped country on the ¼-inch scale.

243. The health of the party was very good throughout the field season and recess.

244. The party was inspected in the field by the Deputy Surveyor General and in recess by the Surveyor General and on several occasions by the Superintendent in charge Burma Surveys.

245. The work of the party will in future lie in Southern India. Its programme for 1909-10 consists of 3,950 square miles of triangulation for 1-inch survey in the South Canara, Salem and Coimbatore districts of Madras and of 2,550 square miles of 1-inch survey and 390 square miles of 2-inch forest survey in sheets 48 $\frac{P}{3, 4, 7, 8, 10, 11, 12, 13, 14, 15, 16}$ and 57 $\frac{D}{3, 4}$, including portions of the Mysore State, Coorg Province and of the South Canara and Malabar districts of Madras.

UPPER BURMA.

No. 10 Party (*vide* Index Map of Eastern Circle facing page 62).

246. The party left its recess quarters at Bangalore on the 18th November 1908, and commenced field work early in December; field work was closed in the end of May 1909, and the party proceeded for recess duties to Maymyo, where, along with No. 11 Party, it occupied an office which has been placed at the disposal of the department by the Government of Burma.

Personnel.

Imperial Officers:

Captain A. A. McHarg, R.E., in charge from 1st October to 25th October 1908.

Captain L. G. Crosthwait, I.A., in charge from 26th October 1908 to 30th September 1909.

Provincial Officers:

Messrs. W. G. Jarbo, E. M. Kenny, Asmat-Ullah Khan and Abdul Rahim, K. S.

Subordinate Establishment:

25 Surveyors, 2 Soldier-Surveyors, 3 Traversers, 1 Draftsman, 1 Computer, 2 Writers and 1 Hospital Assistant.

Photogravure. Survey of India Offices, Calcutta, November 1903.

THE SACRED CAVE AT ALAUNGDAW

LOWER CHINDWIN DISTRICT (BURMA)

Enlarged from a photograph by Captain C. P. Gunter R.E.

247. The outturn and cost-rates of the party were as follows:—.

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		R	
Triangulation	1,686	7·8	
Traversing	226(*a*)	28·8 (*a*)	(*a*) Linear miles.
Detail Survey.			
Original survey, 1-inch scale . .	1,684	31·6	Including fair mapping.
Original survey, 2-inch „ . .	291	54·1	
Revision survey, 1-inch „ . .	829	29·4	
Total Detail Survey .	2,804		

The average monthly outturn per surveyor was 30·9 square miles for 1-inch original survey, 45·9 for 1-inch revision survey, and 10·6 for 2-inch original survey.

The revision survey consisted of the revision of forest areas which had been previously surveyed on the 4-inch scale; it was carried out on blue print reductions of the original maps; the detail was found good, but the contouring had to be done afresh.

The cost-rates of the revision survey were rather high owing to the necessity for heavy jungle clearing.

248. The total cost of the party for the year under report was R1,13,577.

249. The programme of the party consisted of the completion of sheets $84\frac{M}{1,5,9}$ which had been left unfinished the previous season, and the survey of sheets $93\frac{A}{9,10,11,12,13,14,15,16}$ on the 1-inch scale, and the 2-inch survey of all forest reserves not previously surveyed occurring in the programme, as well as the special survey of the Mosit reserve situated in sheets 92 D and 92 H; also advance triangulation and traversing in sheet 92 H. The programme was completed.

250. The area under survey lay chiefly in the Möngmit State and the height above sea-level ranged from 330 feet in the Shweli valley to over 6,000 feet in the south near the Ruby Mines. Except in the Shweli, the country is sparsely inhabited.

251. Mr. E. W. Hedgeland, of the Federated Malay States survey, was attached to the party for the field season for the purpose of studying the methods of work of the Survey of India.

252. Sheets $93\frac{A}{9,10,11,12,13,14,15,16}$ were drawn in the party on the $1\frac{1}{2}$-inch scale and will be submitted shortly for publication. Sheets $84\frac{M}{1,5,9}$ are being drawn in the Burma drawing office. All computations have been completed.

253. No rain fell from November till April, and during this period the health of the party, in spite of the bad reputation of the Shweli valley, was good. After the rains commenced and well on into the recess the party suffered a good deal from fever. Three *khálasis* died during the year.

254. The party was inspected in the field by the Deputy Surveyor General and in recess by the Superintendent in charge Burma Surveys.

255. The programme for next season consists of the triangulation of sheet 92 D and the completion of 92 H, up to the Chinese frontier, and the 1-inch original survey of sheets $92\frac{L}{4,8,12,16}$, $93\frac{E}{3,6,7,9,10,11,13,14,15}$ and $93\frac{I}{1,5,9}$.

SHAN STATES, BURMA.

NO. 11 PARTY (*vide* INDEX MAP OF EASTERN CIRCLE FACING PAGE 62).

256. The party left its recess quarters at Maymyo early in November 1908 and re-assembled there in the middle of June 1909. Much time was occupied in the long journey to and from the frontier and the actual time spent on survey work in the field did not amount to much more than four-and-a-half months.

Personnel.

Imperial Officer:

Captain R. H. Phillimore, R.E., in charge.

Provincial Officers:

Messrs. O. D. Smart, Jagdamba Prasad, S. S. M. Fielding, V. W. Morton, T. P. Dewar and A. A. Graham.

Subordinate Establishment:

33 Surveyors, etc.

257. The outturn and cost-rates were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	REMARKS.
		R	
Triangulation	1,220	6·3	
DETAIL SURVEY.			
Original survey, 1-inch scale . .	3,674	36·3	Including mapping.

The average daily outturn per surveyor was 1·54 square miles. The original detail survey was on the 1-inch scale with contours at 100 feet vertical intervals.

258. The total cost of the party for the year under report was R1,40,506.

259. The programme consisted of the completion of the detail survey of the Southern Shan States included in sheets $93\frac{N}{4, 8, 12, 16}$, $93\frac{O}{1, 2, 5, 6, 9, 10, 13, 14}$, $102\frac{C}{1, 2, 3, 6, 7, 11, 14, 15}$ and $102\frac{G}{2, 3}$, up to the frontiers of China and French Indo-China, and triangulation in the Salween valley for next year's detail survey. With the exception of sheets $93\frac{N}{4}$, $93\frac{O}{1, 2}$, the programme was completed.

260. The area surveyed was situated in the north of the Kengtung State and lay for nearly 200 miles along the Chinese frontier; it included the most easterly corner of the Indian Empire well, to the east of longitude 101° East. The country was well populated by Shans and other hill tribes, and footpaths and mule tracks were frequent. The hills were steep, and though many of the ranges rose to over 8,000 feet, some of the valleys were less than 2,000 feet above sea-level. Though rough and mountainous, the country was comparatively easy to survey, the hill features being bold and not heavily wooded.

261. Escorts were provided for all members of the party, as the country surveyed is seldom visited by travellers other than Shan and Chinese traders, who sell salt to the inhabitants, buying cotton and opium from them in return. The villagers were found most friendly and hospitable, and no difficulty was experienced in obtaining supplies and labour.

262. The area surveyed was mapped on the 1½-inch scale in 19 sheets, *viz.*, $93\frac{N}{8, 12, 16}$, $93\frac{O}{5, 6, 9, 10, 13, 14}$, $102\frac{C}{1, 2, 3, 6, 7, 11, 14, 15}$, and $102\frac{G}{2, 3}$. Seven of these sheets, *viz.*, $93\frac{N}{16}$, $102\frac{C}{1, 6, 7, 14, 15}$ and $102\frac{G}{3}$, will be submitted before the party leaves recess quarters, and the remainder will be completed by April 1910 by a small drawing section, which will be attached to the Burma drawing office for the purpose. The triangulation done in the field was computed in recess and the results were satisfactory.

263. The health of the party was fairly good; the work lay in the most mountainous parts of the Shan States, and in the dry season the climate was perfect. The return journey, however, owing to early rains in May and June, proved most trying.

264. The party was inspected in recess by the Superintendent in charge, Burma surveys.

265. The programme for the next season consists of the completion of the survey on the 1-inch scale of Kengtung and part of the Northern Shan States lying to the south of latitude 23°45′ and east of longitude 98°, excluding the Wa States, which it is not considered advisable to enter at present for survey purposes. Triangulation will be carried out in sheets 93 I, 93 J and 93 N.

EASTERN BENGAL AND ASSAM.

NO. 20 PARTY (*vide* INDEX MAP OF EASTERN CIRCLE FACING PAGE 62).

266. Field work was commenced in the middle of November 1908, and closed early in May 1909 giving a field season of rather less than six months. The recess quarters of the party were at Bangalore, but arrangements have been made to move them to Shillong in 1910.

Personnel.

Imperial Officer:

Major A. Mears, I.A., in charge.

Provincial Officers:

Messrs. P. F. Prunty, C. C. Byrne, Pramadaranjan Ray, J. H. Williams, Amjad Ali and L. Williams.

Subordinate Establishment:

32 Surveyors, 3 Traversers, 2 Draftsmen, 2 Computers, 2 Writers and 1 Hospital Assistant.

267. The outturn and cost-rates were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	REMARKS.
		₹	
Triangulation . . .	680	37·6	Cost-rates include fair mapping.
Traversing	119 (*a*)	40·8	(*a*) Linear miles.
DETAIL SURVEY.			
Original survey, 1-inch scale .	398 (*b*)	26·4	(*b*) Mainly forest clad hills.
,, ,, 2-inch ,, .	660 (*c*)	27·9	(*c*) Flat open country.
,, ,, 2-inch ,, .	400 (*d*)	99·6	(*d*) Forest clad hills.
Revision survey, 1-inch ,, .	123 (*b*)	28·4	
Supplementary survey, 2-inch scale.	452 (*e*)	43·1	(*e*) Open country and low bamboo clad hills.
TOTAL DETAIL SURVEY .	2,033		

The average monthly outturn per surveyor on the 1-inch scale was 21·6 square miles; on the 2-inch scale for original survey in open plains it was 24·5 square miles, for forest covered hills 7·0 square miles, and for supplementary survey 12·6 square miles.

The principal reason for the very slow progress of the work in the forest areas of Cáchár and the Lushai Hills was the extraordinarily dense nature of the jungle growth, quite the worst so far experienced by the party. Large blocks of bamboo forest in the supplementary area account for the small outturn in this class of survey.

268. The total expenditure of the party for the year under report amounted to ₹1,22,215.

269. The programme of the party consisted of the survey of sheets 78 $\frac{P}{9, 10}$ and the completion of 78 $\frac{P}{13, 15}$ on the 2-inch scale and of 78 $\frac{P}{12, 16}$ on the 1-inch scale, also the survey of 83 $\frac{D}{10, 11, 14, 15}$, which consisted to a great extent of forest re-survey on the 2-inch scale. The survey of sheet 78 P was completed, but it was found impossible owing to early rains and to the difficult nature of the country to finish any of the four sheets allotted to the party in sheet 83 D.

270. The supplementary survey was carried out on blue print reductions on the 16-inch cadastral maps of seasons 1894 to 1896. The detail in the cultivated areas was found to be accurate, but the village sites require re-survey. In the large blocks of low bamboo clad "*tilas*" the survey might be classed as original work, the cadastral sheets showing practically no details in these areas. The revision survey was done on blue print reductions of the 2-inch survey executed by Colonel Woodthorpe and Major Badgley in 1881-83. The quality of the old survey was found to be excellent, except as regards the contouring, which had to be re-done.

271. The area under topographical survey embraced portions of districts Sylhet and Cáchár, of the Lushai Hills and of the Hill Tippera State. The greater portion of the country in districts Sylhet and Cáchár was flat, open, thickly populated and closely cultivated. The general level of this country only averages 50 to 60 feet above mean sea-level, and the whole area is covered with a network of streams, *bils* and swamps; and the villages are almost invariably situated along the rivers and streams, the banks of which are, as a rule, slightly above the general level of the country. The country surveyed in the Lushai Hills and in Hill Tippera was hilly and nearly entirely covered with almost impenetrable bamboo, cane and tree forest. Supplies were plentiful in Sylhet and Cáchár, but labour was difficult to obtain, while in the Lushai Hills and the Hill Tippera State these conditions were reversed.

272. The following six sheets will be submitted very shortly for publication:—78 $\frac{P}{9, 10, 12, 13, 15, 16}$, while sheets 83 $\frac{D}{10, 14, 15}$ have been partly drawn, and it is hoped that they will be completed before next recess.

273. The triangulation was based on the Eastern Frontier G. T. series. All computations have been completed, and the results are good. The small amount of traversing done was only carried out with the view of supplying additional points for the detail survey in the low densely wooded valleys, where it was impossible to employ triangulation.

274. The health of the party was fair in the open country until the month of April, when heavy rain caused a good deal of sickness. One surveyor was invalided at the commencement of the season. Six *khalásis* died in the field, one of whom succumbed to injuries received from a tiger. The beast made repeated and determined attacks on the combined camp of two surveyors, three men being mauled before it was finally driven off. The work, in consequence of this animal's presence, had to be stopped in its immediate neighbourhood for the remainder of the season.

275. The party was inspected by the Surveyor General and the Superintendent in charge, Burma Surveys, during the recess months.

276. The programme for 1909-10 comprises the completion of standard sheets 83 $\frac{D}{1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 14, 15}$ on the 1-inch and 2-inch scales, the latter scale being only employed for the survey of forest reserves, and also the triangulation and traversing of degree sheet 78 O.

CANTONMENT SURVEYS.

No. 1 Section.

277. During the season under report this section was employed on the survey of the cantonments in portions of the Ráwalpindi, Lahore, Meerut and Lucknow divisions. Mr. E. G. Little, a retired officer of the Provincial service, continued in charge throughout the season, while Mr. F. C. Saint was attached for duty from the 17th October to the 31st December 1908.

278. The survey of the following cantonments was completed on the scale of 16 inches = one mile, while the bazaars of four were surveyed on a scale of 64 inches = one mile:—Landour, the seven gallies (namely:—Baragali, Kálábágh, Ghora Dhaka and Khanaspur, Changlagali, Khayragali and Barian), Barrackpore, Dum-Dum, Jalápáhár, Ichhápur, Fort William, Shillong, Alipore, Attock and the newly added portions of Jhelum. The triangulation of Dharamsála and traversing of Lucknow were nearly completed, and portions added since last survey to the Nowshera and Meerut cantonments are in hand.

279. The maps of the following cantonments only were submitted for publication :—Landour, Ránikhet, Naini Tál and Alipore. Those of the following cantonments with their bazaars were also sent in :—Sitápur, Delhi, Benares, Mardán, Abbottábád, Dinapore, Bannu, Nowshera and of the Nowshera Cavalry Cantonment surveyed by this section. The following arrears of the late No. 3 section were also drawn and submitted, namely, the cantonments with bazaars of Belgaum, Saint Thomas Mount, Wellington and Bangalore. Altogether 106 sheets in all have been sent in by this section, an outturn considerably in excess of that of the three previous years, and the work of the section is now more or less up to date. The sheets of Nowshera and Nowshera new cavalry cantonments have, however, been returned to be kept in abeyance till certain additions and alterations intended in these cantonments have been made, and can be mapped, and the maps of Barrackpore and Dum-Dum, though ready, are detained owing to some changes contemplated in the bazaar boundaries.

280. The areas surveyed during the season and the cost-rates were :—

	Acres.	Rupees per acre.
Triangulation	1,369	0·91
Traversing	12,594	0·65
Original survey on 16-inch scale	7,556	1·51
„ „ on 64-inch „	136	2·60
Mapping on 16-inch scale	37,118	0·13
„ on 64-inch „	757	2·44

The average outturn per working day was—

Traversing 7 angles and 48 chains—	
Detail survey on 16-inch scale	8·6 acres.
„ „ on 64-inch „	1 acre.

281. The total cost for this section for the year under report was ₹27,901.

282. The head-quarters of the section was moved to Dum-Dum from Ráwalpindi at the end of November 1908, where it remained until September 1909, when it again moved to Lucknow. These expensive moves have enhanced the cost of the section.

283. The section was inspected frequently during the season by the Superintendent, Southern Circle.

284. The programme proposed for the next field season is the survey of the Lucknow and Dharamsála cantonments as well as of the added portions of Meerut and Nowshera cantonments. On completion of this, the section will be disbanded and arrears of drawing will be transferred for completion to the office of the Superintendent, Northern Circle.

No. 2 Section.

285. This section remained in charge of Mr. L. Pocock, a retired officer of the Provincial service, throughout the year under report, and was engaged on the completion on the contouring in Jubbulpore and Pachmarhi, and on the detail survey of the 49 bazaars of the Secunderábád-Bolárum cantonment, on the large scale of 1 inch=50 feet, which has also been finished. No contouring has been done in these bazaars, but numerous heights have been marked on the maps. The theodolite traversing for work on the 16-inch and 64-inch scales was started in the cantonments and bazaars of Mandalay and of Maymyo in Burma, and the Secunderábád cantonment boundary (about 32 miles in length, with about 150 pillars) was also traversed to determine the distance between the pillars and the bearing from pillar to pillar. The traverse work at Maymyo was much retarded by wet weather.

286. The maps of four cantonments, *viz.*, of Mhow, Sehore, Jubbulpore and Pachmarhi, in all 99 sheets, have been drawn, completed and forwarded to the Trigonometrical office for publication. Eleven sheets of the bazaars of Secunderábád have also been sent for publication.

287. The areas surveyed during the season and the cost-rates were :—

	Acres.	Rupees per acre.
Traversing	2,949	1·75
Original survey on 16-inch scale	157	1·4
„ „ on 50-feet = 1-inch . . .	1,818	7·9
Contouring on 16-inch scale	2,352	0·3
Mapping on 16-inch scale	13,218	0·5

The average outturn per working day was :—

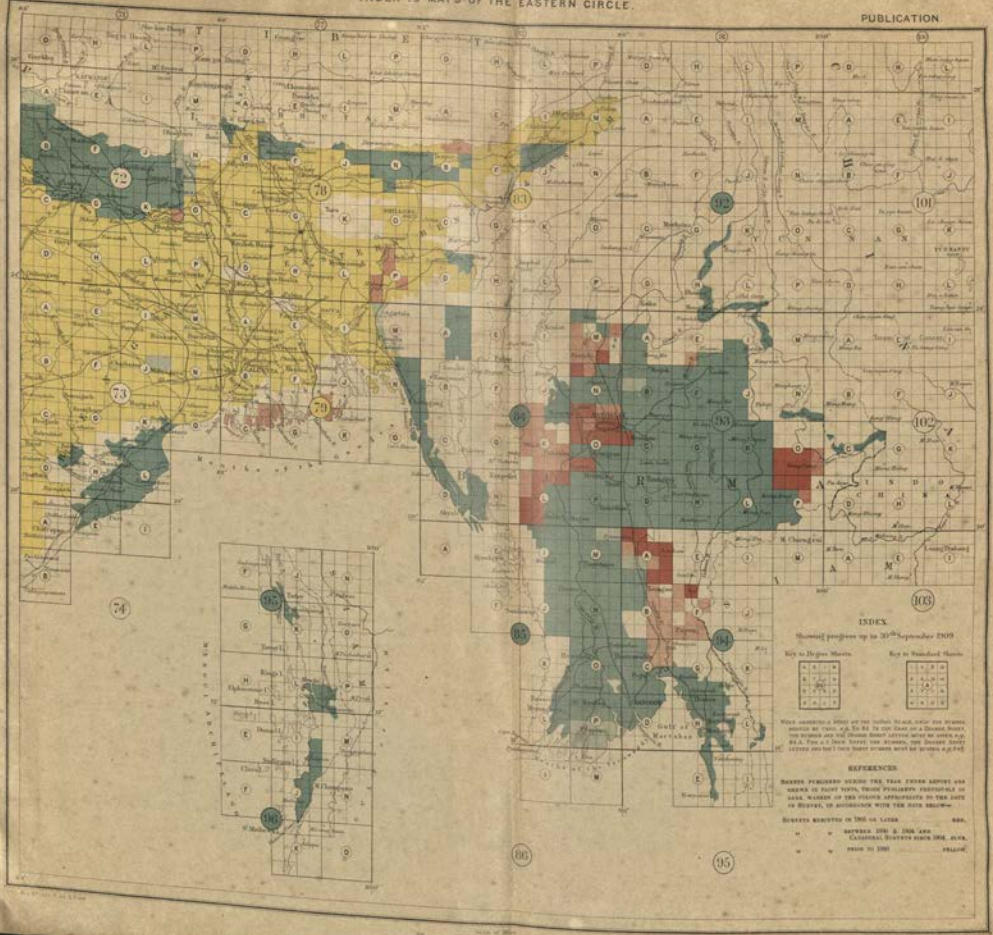
Detail survey on 50 feet = 1 inch . . . . . 0·83 acres.

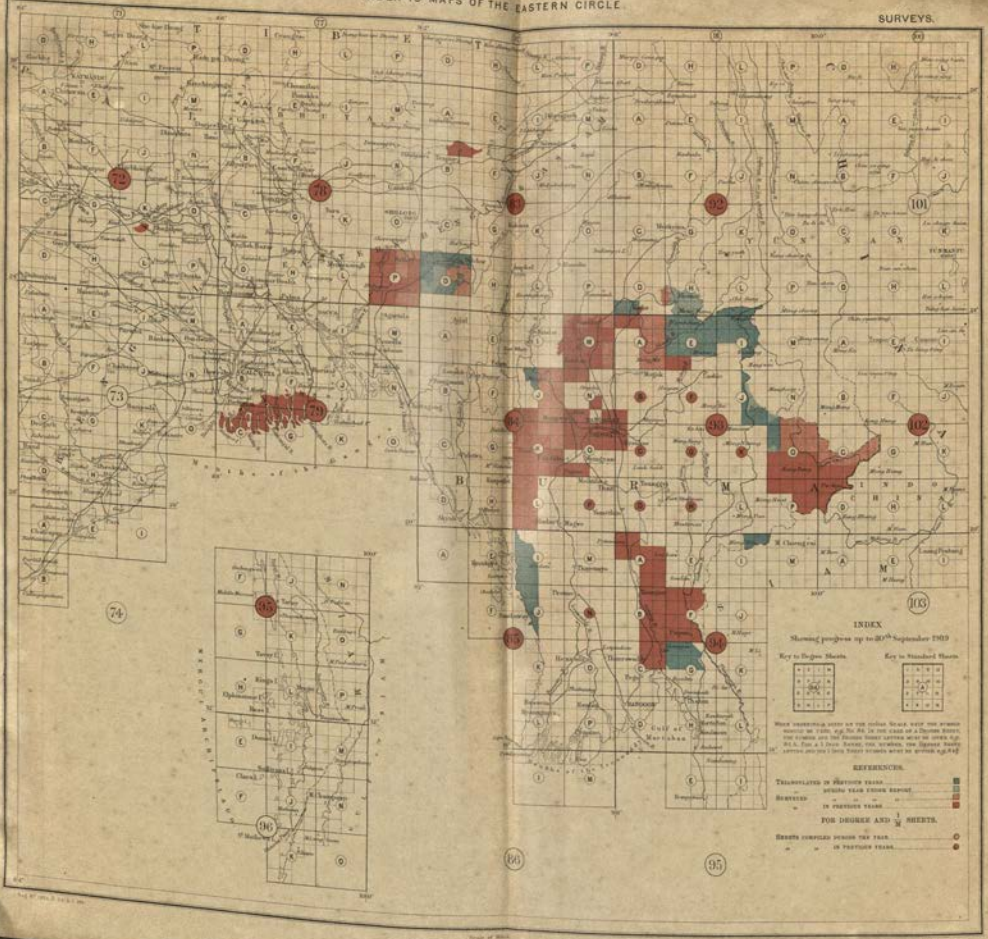
288. The total cost for this section for the year under report was R23,970.

289. The Superintendent, Southern Circle, inspected the section at Seeunderábád in August 1909.

290. During next season the survey of the cantonments of Mandalay and Maymyo, on the scale of 16 inches = 1 mile, and of the three bazaars of the Mandalay cantonment, on the scale of 64 inches = 1 mile, will be undertaken, and it is hoped to complete this work by the 31st March 1910, when the section will be disbanded and arrears of mapping transferred to the Burma Circle. A large amount of the necessary preliminary traverse has been completed, and the detail work will be started in both cantonments early in October 1909, when the head-quarters of the section will move to Maymyo. The area of the two cantonments is about 11 square miles, and that of the bazaars of Mandalay about 304 acres. A great deal of the Maymyo cantonment is covered with forest.

PUBLICATION


INDEX
Showing progress up to 30th September 1909
Key to Degree Sheets.
Key to Standard Sheets.
REFERENCES
Sheets published during the year under report and shown in paint thus, those published previously to 1906, wanting up-to-date information to the date of issue, in accordance with the tints below.
Sheets published in 1905 or later
" " between 1901 & 1905 and Cadastral Sheets since 1904
" " prior to 1901
Gulf of Manaar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FOR DEGREE AND ½ SHEETS.
Sheets compiled during the year
Sheets compiled in previous years

Summary of the Outturn of work of the Field Parties during the year 1908-09.

TOPOGRAPHICAL SURVEYS.

Scale of the map	Number of Party.	Locale of Operations.	Triangulation: Instrument used. Diameter in inches.	Triangulation: Area in square miles.	Triangulation: Square miles to each point trigonometrically fixed.	Triangulation: Square miles to each height.	Triangulation: Minor: Stations fixed.	Triangulation: Minor: Triangular error in seconds.	Triangulation: Minor: Error per mile in feet.	Triangulation: Tertiary: Stations fixed.	Triangulation: Tertiary: Triangular error in seconds.	Triangulation: Tertiary: Error per mile in feet.	Triangulation: Intersected Points: Number of points fixed.	Triangulation: Intersected Points: Error per mile in feet.	Traverse: Area in square miles.	Traverse: Linear miles of new chaining.	Traverse: Number of stations at which the theodolite was set up.	Traverse: Angular error per station in seconds.	Traverse: Linear error per mile.	Detail Survey: Area in square miles.	Detail Survey: Plane-table fixings per square mile.	Detail Survey: Linear miles of test lines.	Detail Survey: Number of "in situ" test fixings.	Detail Survey: Linear miles of Forest boundary traverse.
1	1	Central Provinces and Central India Agency.	6	3,099	6·0	6·0	56	8·0	0·2	12	8·0	(d)	(d)	(d)	...	240	999	3·3	...	951(b) 436(z)	16 11	250	734	...
	2	Central Provinces and Berár	6	2,229	6·0	6·0	32	7·8	0·2	40	10·9	0·2	300	0·5	...	...	...	...	...	2,448(z)	16	468	915	461
	3	Upper Burma . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,095(c) 1,486(a) 511(b)	18	496	669	...
	9	Northern Circle . . .	6	309	4·3	5·5	...	...	...	5	5·2	2·7	55	7·2	...	52	150	...	...	1,313(c) 285(b)	11	544	802	...
	10	Upper Burma . . .	6	1,686	6·9	6·9	5	1·0	0·1	35	6·0	0·2	200	0·3	...	226	1,052	9·1	1·7	1,691(c) 829(b)	12	266	530	...
	11	Shan States . . .	...	1,220	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3,674(c)	...	...	537	...
	12	Northern Circle . . .	6	1,200	1·9	1·9	31	7·3	0·1	18	6·8	0·2	599	0·4	...	...	...	...	...	953(c)	17	...	...	...
	14	" " . . .	6	3,760	7·0	7·0	...	...	...	29	10·7	0·2	292	0·7	...	...	...	...	...	...	...	...	...	...
	17	Bombay Presidency, Central India Agency and Hyderábád.	6	2,169	3·0	3·0	71	10·0	0·7	...	...	...	675	0·9	...	...	...	...	...	2,985(b)	49	...	860	...
	18	Northern Circle . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,503(z)	13	...	219	...
	19	Madras Presidency . .	6	5,859	6·2	6·2	22	5·5	0·1	79	6·0	0·1	858	0·1	...	30	833	4·5	1·0	713(c) 770(b)	22	2	233	...
	20	Eastern Bengal and Assam	6	699	4·3	4·3	...	...	...	32	14·2	0·1	111	0·2	...	119	801	4·8	2·4	399(c) 423(b)	23	424	128	...
		Special Surveys . .	...	8,302	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3,476	...	...	...	...
																			TOTAL	23,531				
2	1	Central Provinces and Central India Agency.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,716(b) 41(z)	10 10	69	94	...
	2	Central Provinces and Berár	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	216(c)	49	63	233	...
	3	Upper Burma . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	39(c)	145	6	9	...
	10	" " . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	291(c)	75	42	33	...
	12	Northern Circle . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,359(c)	19	...	...	...
	14	" " . . .	6	750	6·7	6·7	...	...	...	11	7·6	0·1	260	0·1	...	...	...	...	...	2,830(z)	28	806	...	...
	17	Bombay Presidency, Central India Agency and Hyderábád.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	603(c)	27	134	556	...
	18	Northern Circle . . .	6	1,800	3·3	3·3	...	...	...	40	7·1	2·0	506	0·6	...	2,642	...	...	...	915(z)	25	...	223	...
	19	Madras Presidency . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,865(c)	43	1	329	...
	20	Eastern Bengal and Assam	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,080(c) 452(a)	49	362	411	...
		Coorg	6	2,565	4·7	4·7	35	22·8	0·1	56	14·1	0·2	483	0·8	...	...	...	...	...	528(c)	5	45	438	...
		Special Surveys . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,800	...	...	...	...
																			TOTAL	13,999				
4	2	Central Provinces and Berár	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	461(f)	...	25	70	...
	12	Northern Circle . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	70	...	...	...	...
	17	Bombay Presidency, Central India Agency and Hyderábád.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	205(f)	...	27	...	205
																			TOTAL	70				
		GRAND TOTAL		35,550															GRAND TOTAL	42,600				

(a) Supplementary survey.
(b) Revision survey.
(c) Resurvey.
(d) Computations incomplete.
(e) Original survey.
(f) Linear miles.
(z) New survey.

SPECIAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Spirit Levelling Operations: Miles levelled over.	Spirit Levelling Operations: Trigonometrical stations connected with.	Traversing: Area in square miles.	Traversing: Linear miles of new chaining.	Traversing: Number of stations at which theodolite was set up.	Detail Survey: Area in square miles.	Detail Survey: Linear miles of test lines.
...	25	Tidal and levelling	1,085	3	...	...	...	...	...
16	Detachment	Cantonment Section No. I. . .	...	...	20·0	250	2,597	11·8	51·9
64		Punjab, United Provinces, Bengal and Assam.	...	...				0·2	
16		Cantonment Section No. II . .	...	...	4·6	87	1,714	0·3	0·9
105·6	,,	Central Provinces, Hyderábád and Burma.						2·8	67·6
4	3	Mishmi Country	...	...	...	...	...	250	...

Statement showing the cost-rates of work executed by the Field Parties during the year 1908-09.

Number of Party.	Name and *locale* of field operations.	Cost-rate per square mile.						Total cost for survey year ending 30th September 1909.
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of			Fair Mapping.	
				1″	2″	4″		
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹
1	Central Provinces and Central India Agency.	7·7	13·4	26·3(*h*) 13·0(*a*)	6·6(*h*) 12·0(*a*)	...	6·1	91,793
2	Central Provinces and Berár	11·4	...	15·2(*h*)	55·0(*h*)	5·8(*f*)	8·4	1,02,703
3	Upper Burma	...	...	39·5(*d*)(*c*) 27·0(*g*)(*c*) 20·0(*a*)(*c*)	96·2(*c*)	...	...	96,892
9	Northern Circle	11·3	34·9	17·2(*b*) 14·1(*a*)	...	...	9·8	1,30,298
10	Upper Burma	7·8	28·8	31·5(*d*)(*c*) 29·4(*a*)(*c*)	54·1(*c*)(*d*)	...	...	1,13,577
11	Shan States	6·3	...	36·3(*d*)(*c*)	...	...	...	1,40,506
12	Northern Circle	...	...	13·9(*d*)	42·5(*d*)	6·2(*a*)	2·4	84,012
14	„ „	4·1 4·2	...	...	20·2(*h*)	...	7·6	1,10,538
17	Bombay Presidency and Central India Agency and Hyderábád.	5·2	...	13·9(*a*)	19·1(*b*)	5·2(*f*)	5·2	93,509
18	Northern Circle (Dera Ismail Khán). „ „ (Punjab Rivers) „ „ (Bári Doáb)	3·6	9·3(*e*) 13·5(*e*) 24·0(*e*)	12·4(*c*)(*h*)	33·7(*c*)(*h*)	...	...	1,29,760
19	Madras Presidency	3·1	40·3	26·1(*d*)(*c*) 15·0(*b*)(*c*)	62·4(*d*)(*c*)	...	...	1,16,386
20	Eastern Bengal and Assam	37·6	40·8	26·4(*d*)(*c*) 28·4(*a*)(*c*)	55·0(*d*)(*c*) 43·1(*g*)(*c*)	...	...	1,22,215
	Coorg Detachment	6·9	...	...	36·9(*d*)(*c*)	...	...	36,631
	TOTAL	...	...	...	...	...	...	13,68,870

(*a*) Revision Survey.
(*b*) Resurvey.
(*c*) Inclusive of mapping.
(*d*) Original Survey.
(*e*) Rate per linear mile.
(*f*) Boundary Survey.
(*g*) Supplementary Survey.
(*h*) New Survey.

Cantonment Surveys.

Number of Party.	Nature of field operations.	Cost-rate per acre.						Total cost of party inclusive of charges for instruments for Local Governments.
		Traverse.	Detail survey.			Mapping.		
			16″	64″	105·6″ or 50″=1 inch.	16″	64″	
		R	R	R	R	R	R	R
Detachment.	Cantonment No. I. Section,	0·7	1·5	2·6	...	0·1	2·4	27,901
„	Cantonment No. II. Section,	1·8	1·4	...	7·9	0·5	...	23,970

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INDIA
SHEWING THE PROGRESS OF SURVEY
To 1st October 1930
REFERENCE TO COLOURS.
Surveyed during previous Seasons
Do. 1929-30
Triangulated & Traversed during previous Seasons
Surveyed during previous Seasons on 2 Scale
BAY OF BENGAL
INDIAN OCEAN

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